MACHINE DESIGN

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Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

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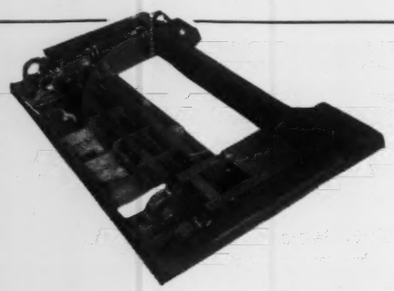
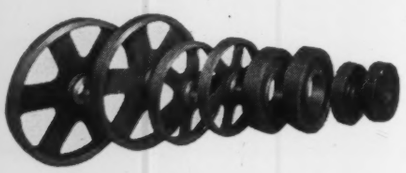
This traveling crane was improved by FLAME-CUTTING

This traveling crane illustrates an extensive use of flame-cutting by the Shaw-Box Crane and Hoist Division of Manning, Maxwell and Moore, Inc.

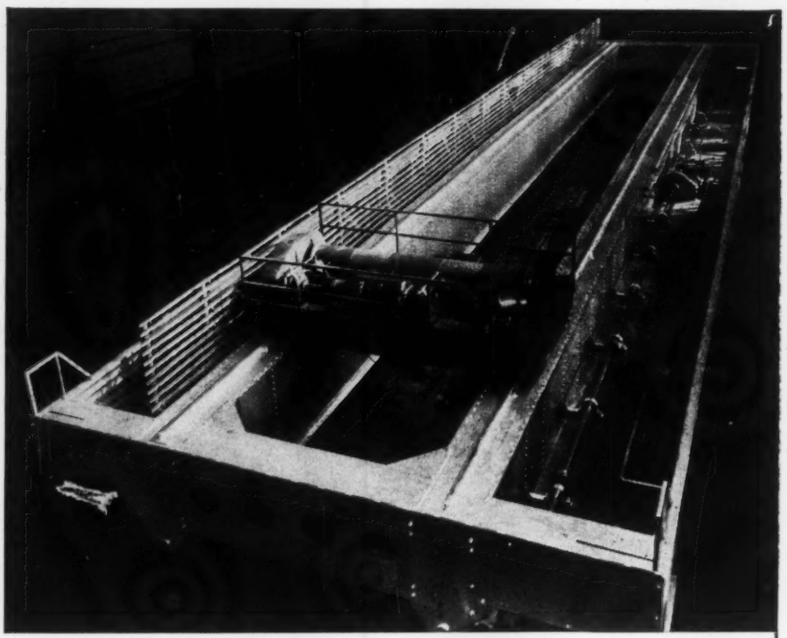


Flame-cut parts were used in the assembly of the trolley frame to assure maximum strength from minimum weight.

The irregular steel shapes for the end trucks supporting the trolley frame were flame-cut quickly and economically.



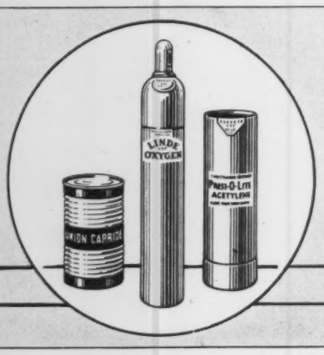
These gear blanks, assembled from strong flame-cut parts, were machined and put in use throughout the crane.



THIS 20-ton capacity, 120-foot span, electric traveling crane is light in weight—yet is exceptionally strong—because many of its parts were flame-cut from strong, tough, rolled steel. The light weight of this crane, achieved by flame-cutting and welding, increased its lifting capacity. It can carry ladles of molten metal to the molds faster—yet it consumes less power than earlier models. The time required to build it, and its overall cost, also were reduced.

Other Oxy-Acetylene Applications

Flame-cutting is one of the many applications of the oxy-acetylene process which are useful and profitable in the manufacture of equipment. Parts subject to exceptional wear can be flame-hardened or hard-faced. Where annealing is required, surfaces can be flame-softened. Parts, even when made of different kinds of metal, can be welded to form strong, smooth-finished and long-lasting units. Write any Linde office for additional information.



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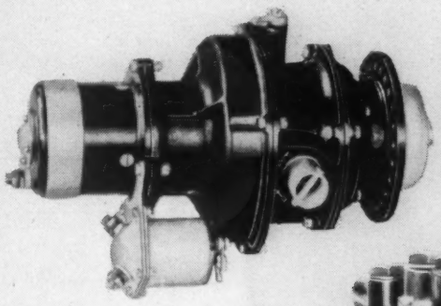
Back in 1922, when the aircraft industry was still an infant, Eclipse Aviation was already using DOWMETAL* in aircraft accessories. Today Eclipse is the nation's largest maker of such equipment. Nearly every item in its wide line of aircraft and aircraft engine accessories, including starters, generators and radio power equipment, incorporates DOWMETAL. For in addition to its extreme lightness, DOWMETAL meets the aircraft industry's every requirement for strength, toughness and durability.



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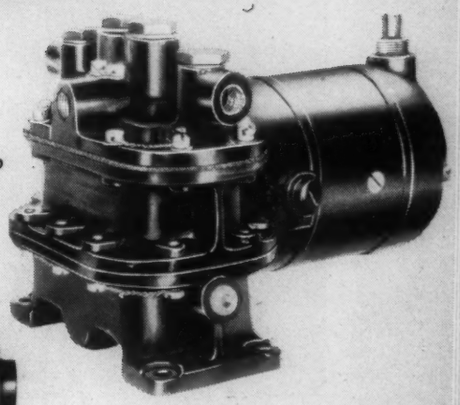
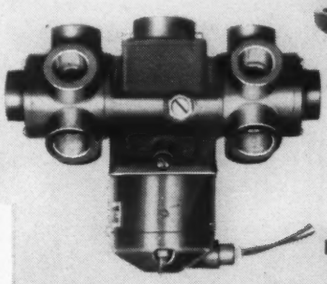


Anti-Icer Pump



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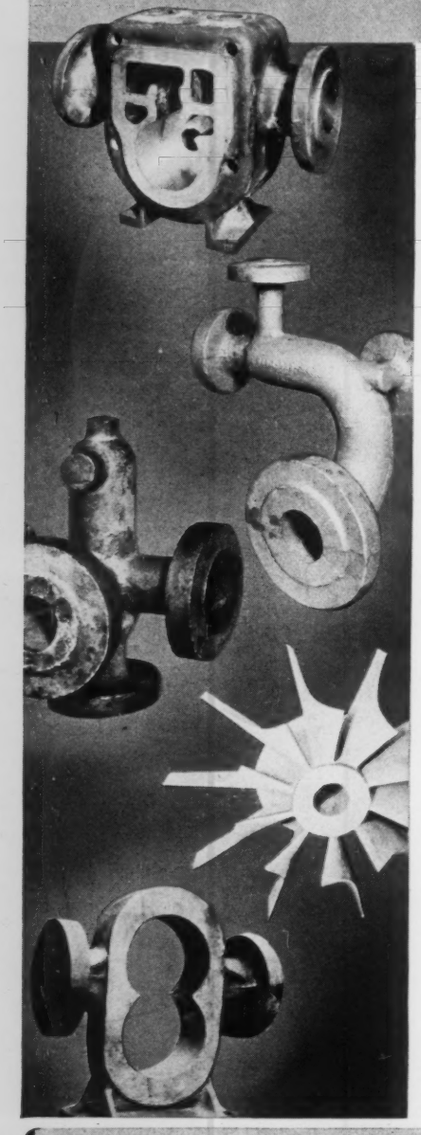

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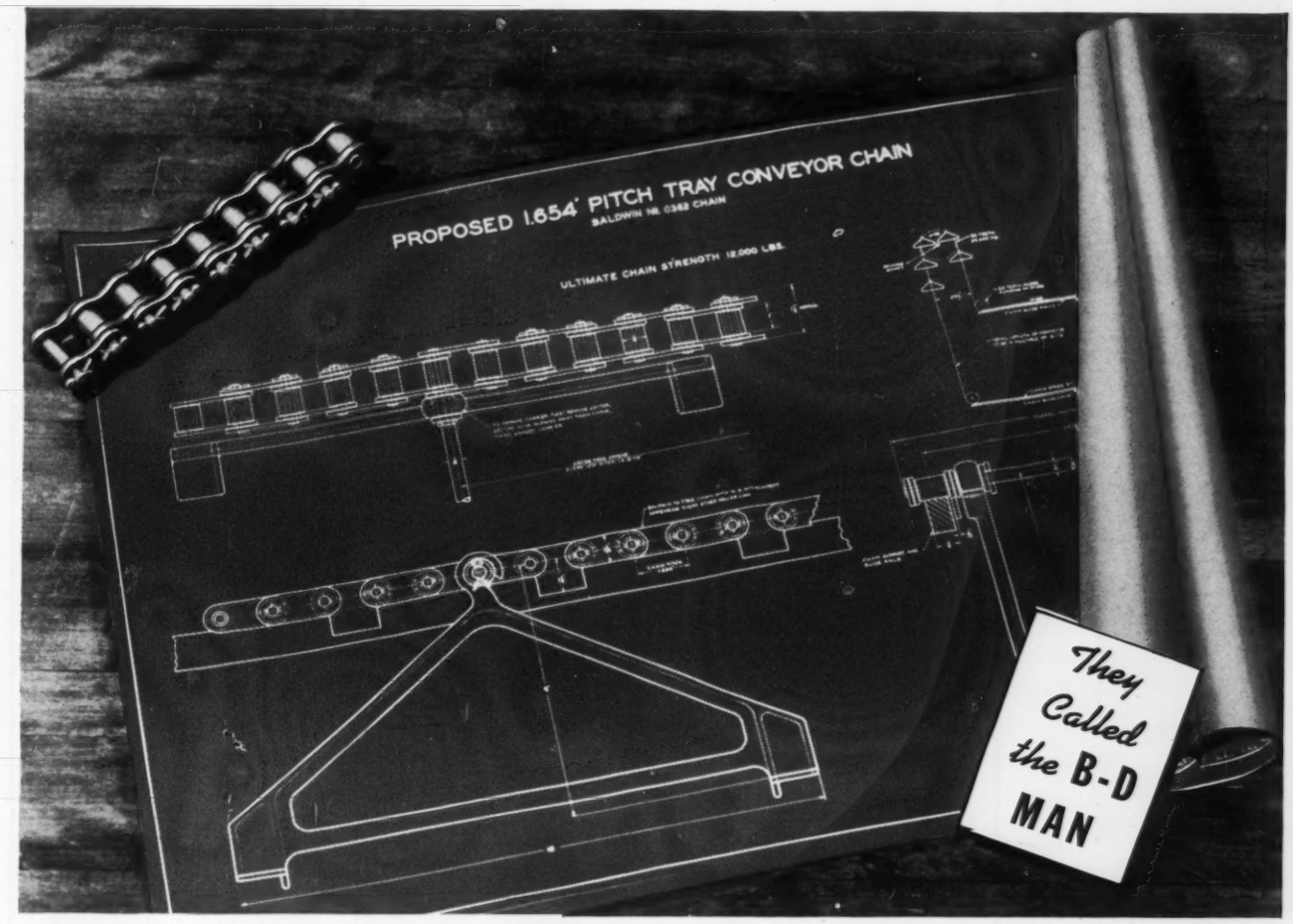

How B-D Roller Chain Helps Designers

A sailor uses the *spokes* to turn the wheel. Roller chain acts the same way on a sprocket's teeth, making it the most efficient and positive drive known to science. *Take a tip from the Skipper's grip.*

Here is the blueprint for a Tray Conveyor installation. It represents a pooling of the customer's knowledge of his particular requirements and the Baldwin-Duckworth engineering department's knowledge of the versatility of roller chain.

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But it does take specialized experience to put all these qualities to work for a manufacturer. We can do for you what we did for the company that wanted this tray conveyor—if you will call on us.

BALDWIN-DUCKWORTH CHAIN CORPORATION
Springfield, Mass.

Factories at Springfield and Worcester, Mass.

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Fig. 1641 Pat. App. for

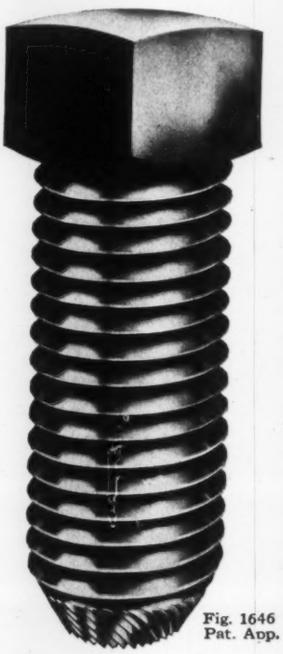

Fig. 1646 Pat. App. for

KNURLED POINT

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SELF-LOCKING
Square Head
SET SCREW

Here's another new "Unbrako" product with countless uses. *"Unbrako" Self-Locking Square Head Set Screw.* These also have the knurled points so they stay-put despite the most severe vibration. Can be adjusted as often as required without affecting the locking efficiency. Write for details.

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To: BOSTON GEAR WORKS, INC., NORTH QUINCY, MASS.

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- ☐ General Catalog #52 giving complete specifications and list prices of all Boston Gear Power Transmission Equipment available from stock.
- ☐ Folder #4-38 giving complete specifications and prices of Oilite Self-Lubricating Precision Bronze Bearings.
- ☐ Folder #5-37, a descriptive folder only of Boston Gear Power Transmission Equipment.

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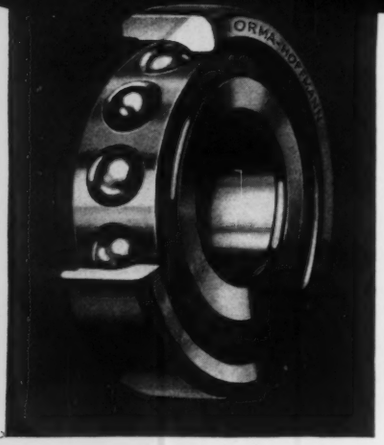
ULTRA-PRECISION BEARINGS



"NORMA-HOFFMANN"

When faced by such a super-speed problem as this—over 1200 revolutions per second—in its 1/6 hp. B-1 AIR TURBINE GRINDER, the Onsrud Machine Works, Inc. (Chicago, Ill.) turned naturally to NORMA-HOFFMANN. Their engineers—with a knowledge born of their long experience with NORMA-HOFFMANN BEARINGS in other Onsrud units—recognized that only bearings with NORMA-HOFFMANN-ULTRA PRECISION characteristics could function satisfactorily at this terrific speed. The results have proved the correctness of their judgment.

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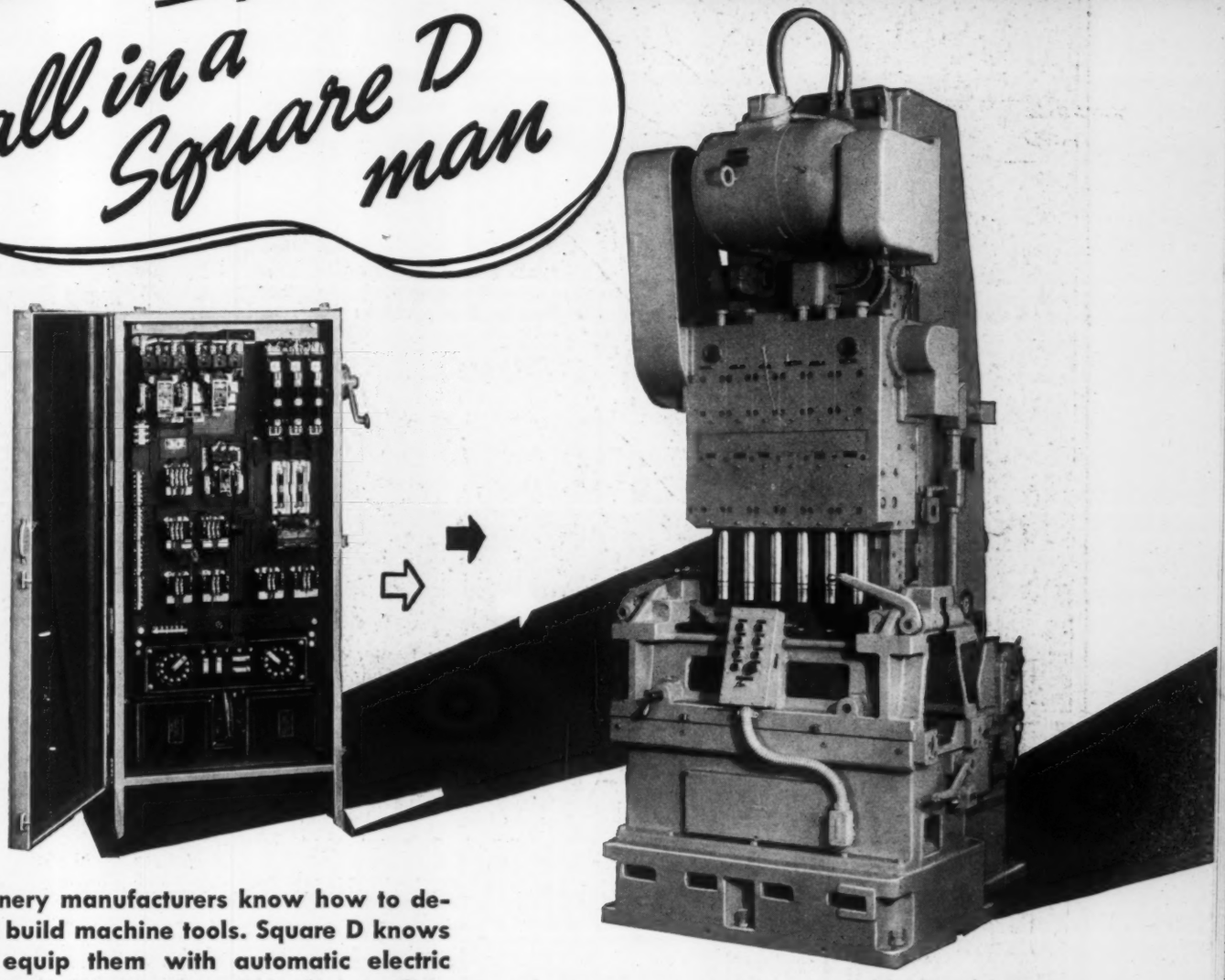
Call in a Square D man



● Machinery manufacturers know how to design and build machine tools. Square D knows how to equip them with automatic electric motor control. Working together, they produce some remarkably fine results.

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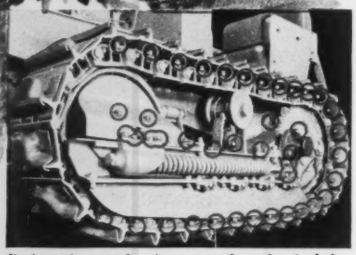
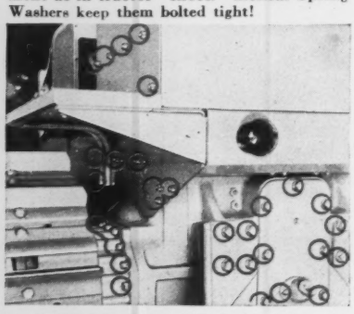


Perhaps in no other instance of mechanical design are parts subjected to such terrific punishment as in tractor "shoes." Helical Spring Washers keep them bolted tight!



Roadless terrain is everyday fare for a tractor. In spite of severe thrusts, stress and vibration, rear end parts are kept bolted tight by the *Live Action* of Helical Spring Washers.

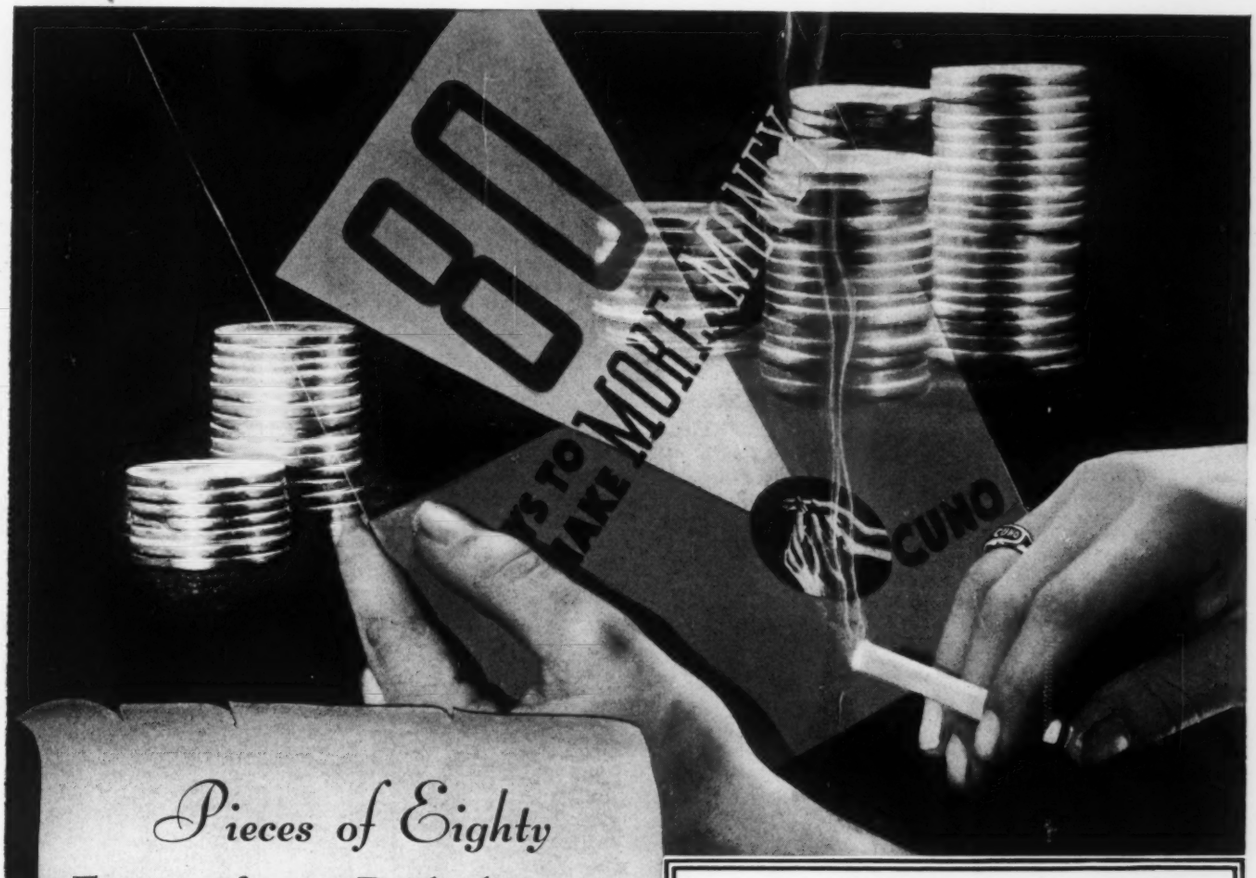
Where it's MACHINE vs. HELL!

Vibration mounts to a thundering pitch in tractor service! But Helical Spring Washers keep bolted parts tight! Here's why. Bolts do not loosen *initially* because of backward turning of the nut . . . but because of wear, scale, rust, breakdown of paint and bolt stretching. Only the *long range* Live Action of Helical Spring Washers exerts the powerful, *maintained* pressures on thread surfaces, to automatically compensate for initial looseness and to *keep* bolted assemblies tight. Be safe and specify only Helical Spring Washers.

SPRING WASHER INDUSTRY
616 WRIGLEY BUILDING · CHICAGO, ILL.

. . . it takes Spring Washers to keep bolted parts tight

ONLY A HELICAL SPRING WASHER HAS LIVE ACTION!



Pieces of Eighty

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#59 A *continuously cleanable* Cuno, handling 86 gallons per minute of (described) fluid, was checked after 3 years in service and found perfect.

#60 The engineering department of one manufacturer reported their cost of (described) was reduced *seventy-five per cent* after their Cuno filter was installed.

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Company..... City..... State.....

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TELL us what the spring must do and we will provide you with American Quality Springs that will do the job the way you want it done. For if we do not already make a spring of the type you need, our engineers will design a spring that will answer your problems.

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UNITED STATES STEEL

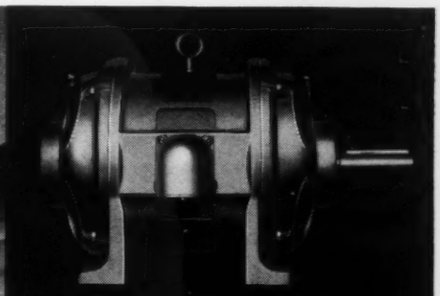
AN ORDINARY-LOOKING ROOM —for an extraordinary operation

The rotor casting room at Delco Products may *look* uninteresting—but what takes place in this room will interest every engineer who specifies or purchases electrical motors. In this room Delco employs a superior type of die-casting to cast conductors, end rings and fan blades as a unit—no solder, loose rotor bars or fan blades. Structural weakness, that sometimes results from castings where pressure is supplied by gravity only, or where the die is cast from two sides and depends on fusion, is eliminated. *Delco rotors are cast by high pressure in a single uniflow direction,* and every rotor is as sound and sturdy as modern manufacturing methods can make it!

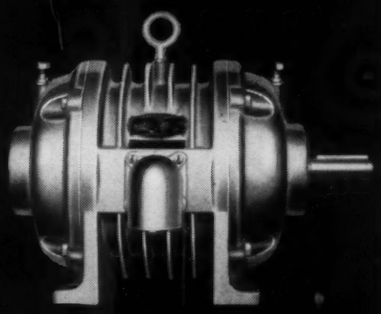
But this room is remarkable as well for the extreme care exercised here. In the great electric melting pots the temperature of the molten aluminum is held at correct point. When ready for casting, both the rotor core and the mold are preheated to the proper temperature to prevent possible chilling of the aluminum and to assure the uniformity of rotor structure. These outstanding features are typical of every operation at Delco Products. That is why we ask you to *look within* the motor you specify.

EVERY DELCO MOTOR IS DYNAMICALLY BALANCED

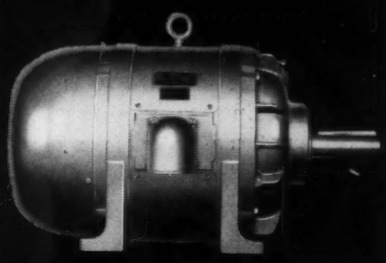
No motor leaves Delco Products that has not been dynamically balanced on a specially-designed balancing machine. Delco balances every motor. Each end of the rotor and shaft is first balanced independently while the machine indicates exactly how much compensation is required and where it should be applied. After all adjustments have been made, the complete rotating assembly is given a final check. Delco motors assure satisfactory balance.



Open Frame, Sleeve or Ball Bearing



Totally Enclosed Ball Bearing



Totally Enclosed Fan-Cooled Ball Bearing

Fractional Horsepower Motor

• • •

Delco industrial AC motors are available in various types, possessing electrical and mechanical characteristics to meet practically every requirement.

Normal starting torque—normal starting current—high starting torque—low starting current—as well as high slip. Each type available in open frame, sleeve or ball bearing—totally enclosed ball bearing—totally enclosed fan-cooled ball bearing—also multi-speed motors. Electrical and mechanical modifications available. Delco motors comply with NEMA standards.

DELCO MOTORS

DIVISION OF GENERAL MOTORS CORPORATION

DELCO PRODUCTS • DAYTON OHIO

Topics

DESPITE the fact engineers in general are firmly convinced inventions in the long run contribute much more to material progress than they detract, the argument over mechanization vs. manpower rages on. Substantial backing for the scientific side was furnished recently by Justin W. Macklin, United States patent office, in an article in *Think,* magazine published by International Business Machines Corp. Fifteen new major industries and an unknown number of smaller ones have been brought into being in the last 60 years, Mr. Macklin says, and each new industry—take for example the automotive—has helped other lines. Between 1900 and 1934, 1,330,000 patents were issued in the United States and even more may be expected in the second third of the century, because the number of patents per decade is steadily increasing. To debunk further the claim that inventions disturb social conditions, Mr. Macklin says that "although the influence of an invention may be revolutionary, there is usually opportunity to anticipate its effect upon society. From the origin of an invention to its social effects the time interval has been considered as being about 30 years." This thought, however comforting, merits more attention from engineers. Much ammunition for opponents of scientific progress may be dissipated through careful consideration leading to the amelioration of mechanization's temporary effects.

♦

WHILE speaking of inventions, a recent action of the Packaging Machinery Manufacturers institute is pertinent because it might well be deliberated by makers of other machines. The Institute has prepared and distributed a patent protection clause, to be inserted in contracts covering the purchase of equipment manufactured by its members. Liability of the vendor in patent infringement suits is limited by the clause to damages or awards not exceeding the purchase price of the equipment, plus the costs of defending the suit. At its recent annual meeting, the Institute stressed the need for a clause to define the vendor's responsibility and protect him against possible consequences of signing unlimited guarantees which are sometimes inserted in contracts. The latter practice is considered unwise because of the prohibition in the Robinson-Patman act of discriminatory favors to customers.

♦

A NEW freighter now in deep sea service has certain design features of broad significance. Built and operated by the Dolomite Marine Corp., Rochester, N. Y., DOLOMITE 4 was made of electrically welded steel channels bent to form her main structure. For use in bulk transportation of lye and other highly corrosive chemicals, this ship has five main bulkhead cargo holds lined with 16-gage sheet nickel, spot welded to the frame and arcwelded on the seams. More than 60,000 pounds of nickel were used for her main holds, including 1200 pounds of nickel welding wire. For cleaning, valves similar to warehouse fire extinguishers, introduce live steam into holds. The steam removes every vestige of the cargo, which is then pumped out through a false bottom. Cleaning is accomplished in about six hours.

♦

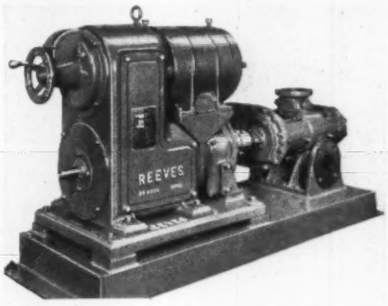
NEW applications of plastic materials may result from recent development of methods for plating them with metals. To overcome the basic difficulty in making metal stick to glossy plastic surfaces, a bond coat consisting of two chemical substances—applied separately—is put on during tumbling or agitation. This gives the plastic piece a smoky gray surface which when immersed in the plating bath has a natural affinity for the metal plate. A plating of any thickness up to 1/100-inch has been applied. The coating can be scraped off with a sharp instrument, of course, but it is claimed it doesn't peel.

♦

A PARTICULAR plastic, Polaroid, is being used in an unusual way. Having the power to polarize light so that it vibrates in only one plane, Polaroid is the *sine qua non* of an eye shamming test recently made available by American Optical Co. to protect both employer and employe in cases where industrial eye injuries lead to claims or suits for damages. This test determines instantly and conclusively whether or not an eye has actually suffered loss of sight and also measures visual acuity of the eye. Equipment consists of a projector, a small

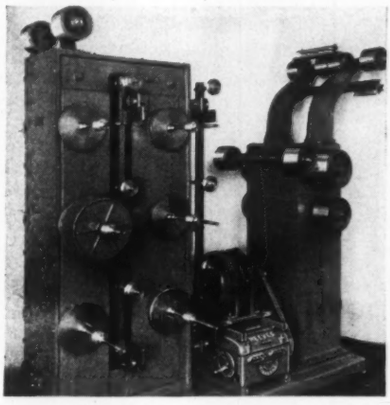
(*Concluded on Page* 76)

What's New IN VARIABLE SPEED CONTROL



APPLIED TO PUMPS

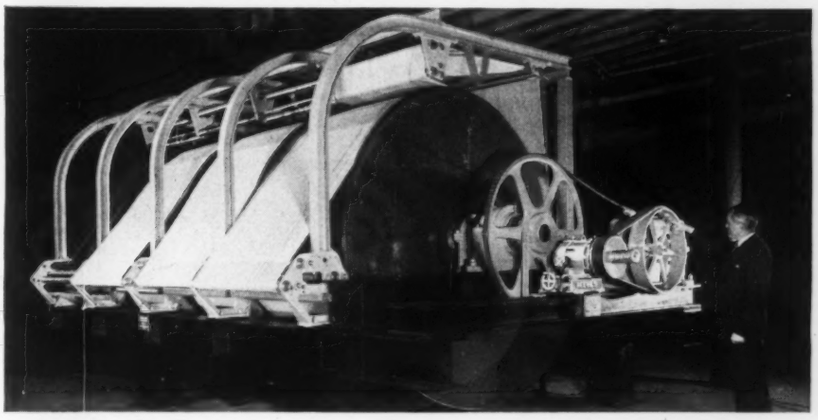
This Northern Pump, now in the plant of a leading corn products refining company, is used for handling a protein solution of water. By turning the handwheel of the REEVES Motodrive with which the pump is standardly equipped, varying capacity flow from 10 g.p.m. to 3 g.p.m. is easily and quickly obtained. The Motodrive combines motor, variable speed mechanism and gear reducer in a single unit.



ON WIRE PULL-OUT

This Pull-Out is used to take wire through oven at uniform rate of speed in enameling magnet wire on American Insulating Machinery Co.'s "H-20" Enameling Machine. By driving through a REEVES Transmission, speed of Pull-Out can be varied accurately for different wire size and enamels.

SPEED VARIATION ON CORD VACUUM FILTER



Filtering is accomplished through a belt of cords, which runs over a revolving drum, on the recently introduced Louisville-Wright Cord Vacuum Filter. Clogging is eliminated, a constant filtration rate secured and a high recovery effected. These filters are used in food product clarification, vegetable carbon decolorization, sewage disposal, brewing, distilling, chemical processes, etc. Infinitely variable drum speed is essential to meet varying conditions of wet materials. To fulfill this requirement Louisville Drying Machinery Company equips this filter with the REEVES Vari-Speed Motor Pulley, and any needed drum speed is instantly and accurately available over a 3:1 ratio of speed range.

REEVES ADVANTAGES FOR MACHINE BUILDERS

● The wide range of sizes and models of the three basic units in the REEVES complete line makes it easy for machine designers and builders to incorporate these thoroughly tested and approved units as standard equipment. Open and fully enclosed models, for vertical or horizontal service. REEVES leadership in Variable Speed Control is an asset for sales which you cannot afford to overlook.

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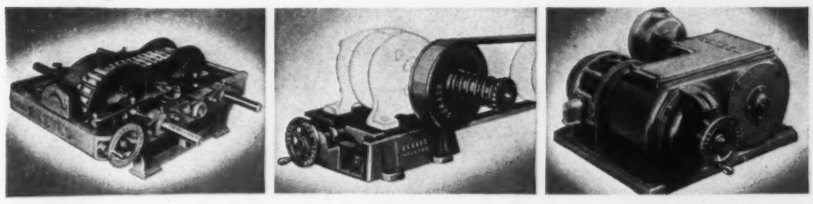

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Send catalog G-384, describing your complete line of Speed Control equipment and its use by 1300 machine builders.

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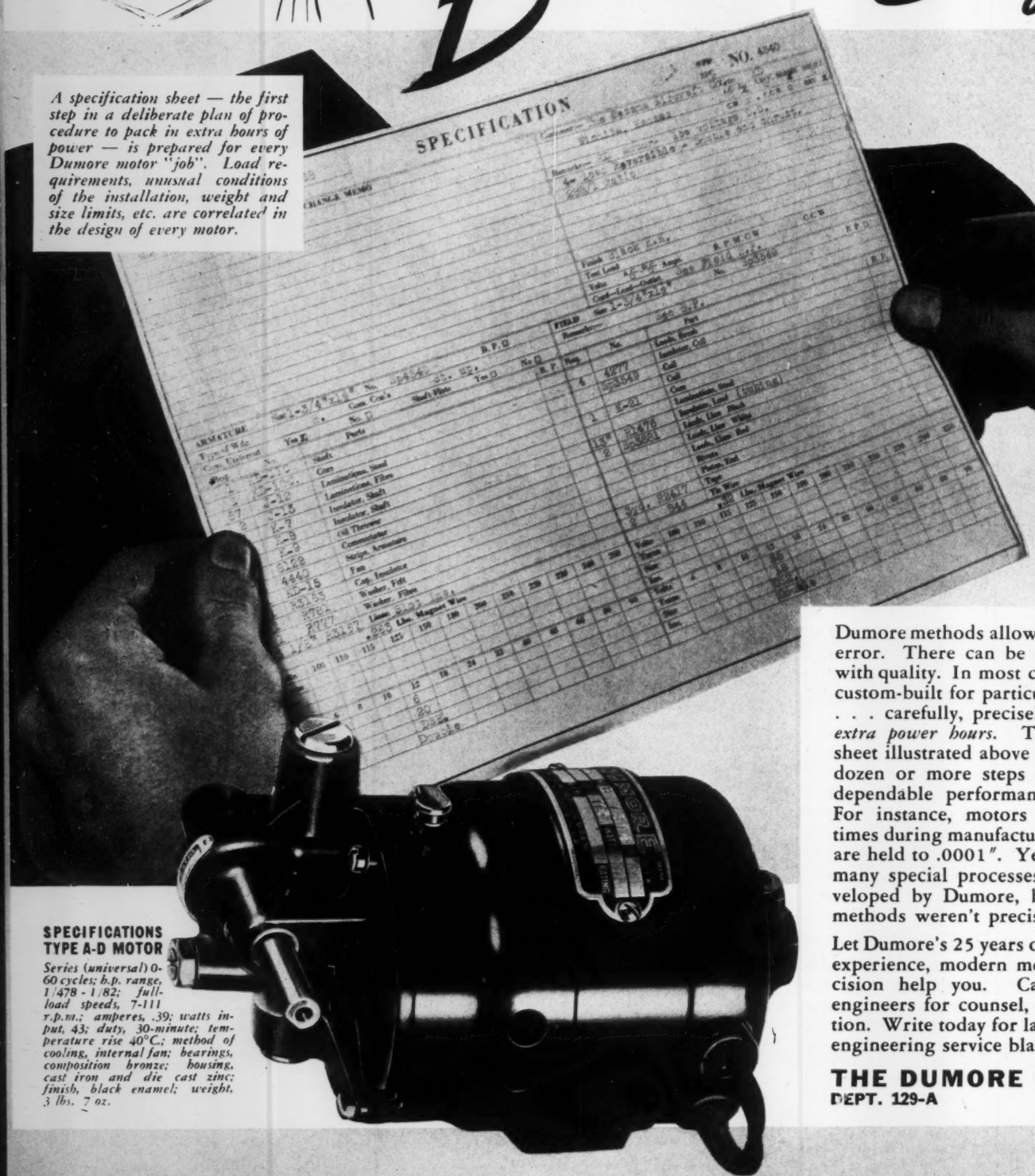
DUMORE GIVES A *Baker's Dozen*

A specification sheet — the first step in a deliberate plan of procedure to pack in extra hours of power — is prepared for every Dumore motor "job". Load requirements, unusual conditions of the installation, weight and size limits, etc. are correlated in the design of every motor.



SPECIFICATIONS TYPE A-D MOTOR

Series (universal) 0-60 cycles; h.p. range, 1/478 - 1/82; full-load speeds, 7-111 r.p.m.; amperes, .39; watts input, 43; duty, 30-minute; temperature rise 40°C.; method of cooling, internal fan; bearings, composition bronze; housing, cast iron and die cast zinc; finish, black enamel; weight, 3 lbs. 7 oz.

Dumore methods allow little chance for error. There can be no compromise with quality. In most cases motors are custom-built for particular applications . . . carefully, precisely built to give *extra power hours.* The specification sheet illustrated above is only one of a dozen or more steps taken to insure dependable performance, longer life. For instance, motors are tested five times during manufacture . . . tolerances are held to .0001″. Yes, and there are many special processes employed, developed by Dumore, because the old methods weren't precise enough.

Let Dumore's 25 years of motor making experience, modern methods and percision help you. Call on Dumore engineers for counsel, without obligation. Write today for latest catalog and engineering service blank.

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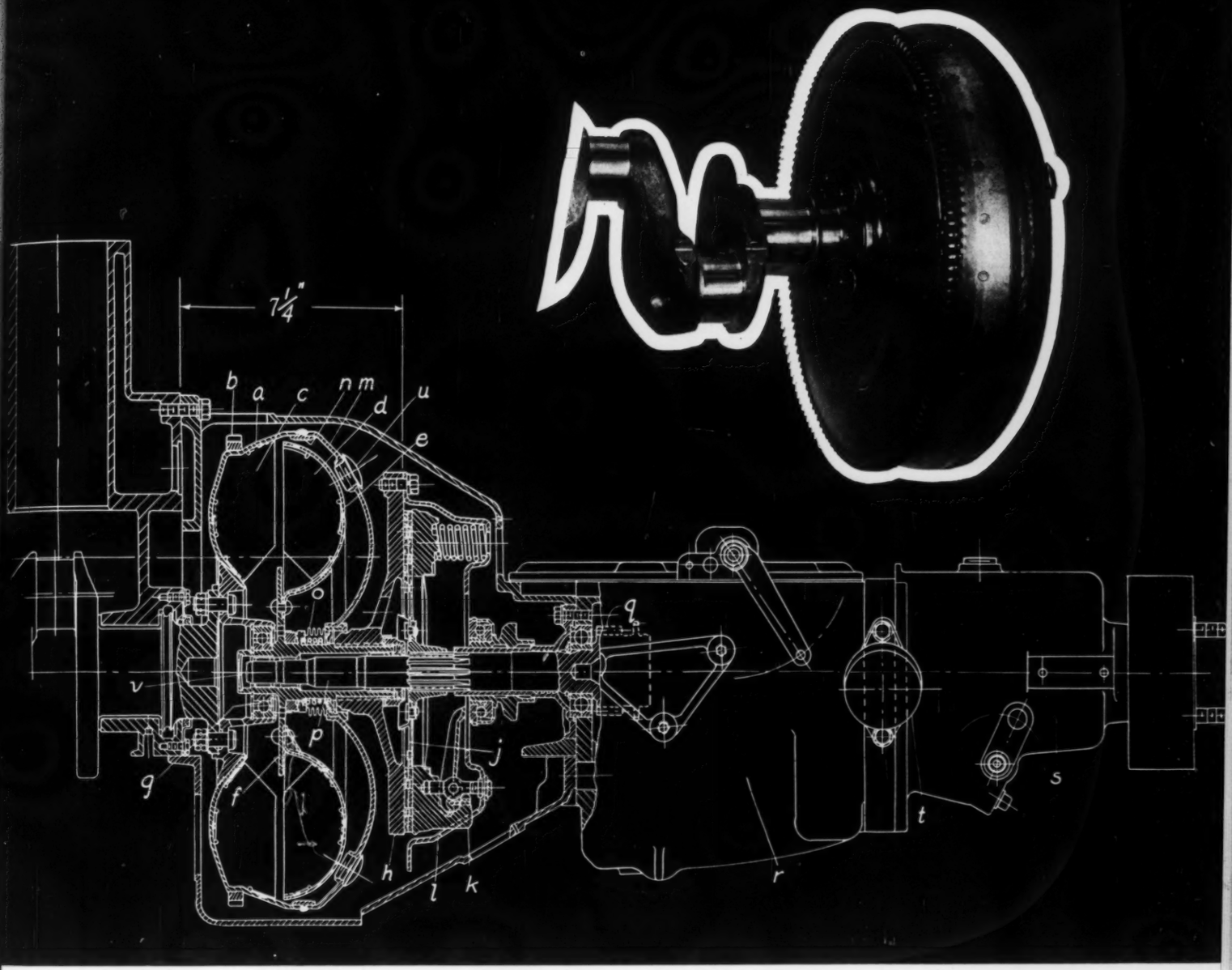
DUMORE MOTORS

FOR *Extra* POWER HOURS



Fluid Flywheel Marks New Era in Auto Transmissions

By Austin M. Wolf
Consulting Automotive Engineer

MACHINE DESIGN
January 1939

RADICALLY different forms of transmission, industrial as well as automotive, may well result from the adoption by Chrysler Corp. of the fluid flywheel on its Custom Imperial model. This is the first commercial adaptation of the device in this country for motor vehicles, although it has been used for many years on the English

Fig. 1—Top—Section through Chrysler fluid flywheel. Impeller casing is mounted on the engine crankshaft through the intermediary of a forging
Fig. 2—Insert—Fluid flywheel attached to end of crankshaft

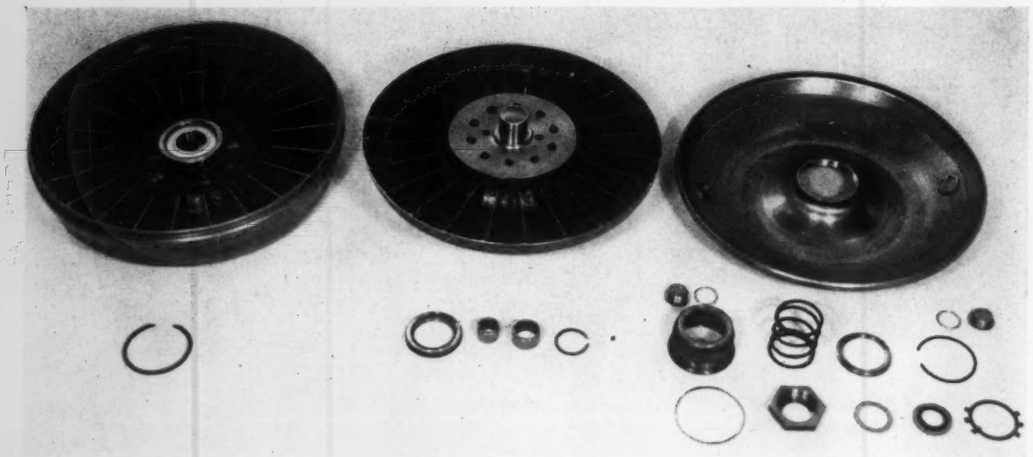


Fig. 3—Fluid flywheel disassembled, showing various component parts. Twenty-two impeller blades are each held to the casing by three spot welds, a similar construction securing the 24 runner blades to the runner casing

Daimler. A patent on a fluid flywheel, assigned to the Chrysler Corp., was discussed in *M. D.*, Feb., 1937, p. 60, and the latest Chrysler transmission was mentioned in *M. D.*, Nov., 1938, p. 25. Complete application details have not been available heretofore, however.

The Chrysler device differs from previous constructions in its simplification of design which also permits the use of stamped, pressed and forged steel parts. A stereotyped central annulus forming a wall, half in the impeller and half in the runner, around which the fluid circulates, has been eliminated. The impeller casing *a* in *Fig.* 1 is mounted on the engine crankshaft through the intermediary of a forging piloted on the crankshaft flange which normally mounts the regular flywheel. These parts are welded together. The casing departs from a true curve to mount and center the starter ring gear *b*, there being ten welds to unite these parts as indicated in *Fig.* 2.

The impeller blades *c*, of which there are 22 (see *Fig.* 3) are each held to the casing by three spot welds. A similar construction secures the 24 runner blades *d* to the runner casing *e*. The latter is riveted to the forged runner hub *f* which is piloted at its front end by the flywheel-mounted ball bearing *g*. The rear end is externally splined (see *Fig.* 1) and engages the hub of the friction clutch member *h*. Its finished rear face replaces the customary flywheel contact surface for the clutch drive plate *j* and mounts the pressure plate *k* and cover *l* with remaining mechanism as usual. The friction clutch is the standard Borg and Beck design and is operated by the usual clutch pedal and throwout.

Casing Permits Simple Sealing Method

Casing portion *m* takes no part in the actual drive but is welded to the impeller casing *a* as will be noted in *Fig.* 1, being first centered on the flange *n*, readily seen in the drawing. Casing *m* permits a simple method of sealing, comprising the Sylphon bellows *o* between the inner right sleeve and the antifriction ring at the left. An internal spring maintains contact of the latter with a runner hub hardened ring.

Transmission shaft *p* with the regular constant mesh gear *q* at the right is piloted within the runner hub *f* by a needle bearing at each end. The fluid flywheel is purely a clutch and not a torque converter, therefore the customary transmission *r* is provided. An overdrive unit *s* is located back of the transmission and the solenoid *t* permits optional return to direct drive.

The casings *a*, *e* and *m* are pressed cold-rolled steel units and the blades *c* and *d* are stamped cold-rolled steel. A space of ¼-inch lies between the vertical faces of the blades. When the engine is running, centrifugal force causes circulation of the fluid in a clockwise direction, looking at the front in *Fig.* 1, and the runner will be caused to rotate in the direction of the impeller, increasing its speed as the engine speed is increased.

Clutch Has Infinite Slip Capacity

This type of clutch has an infinite capacity to slip as compared to the friction clutch and cannot grab. A slight slip occurs at all times, but without a direct connection the operation is particularly smooth and eliminates shocks in the entire driving system. There is sufficient surface area on casings *a* and *m* to dissipate any heat generated. Of course where a torque converter is used, considerable heat is generated and it must be dissipated from a cooling system. A low viscosity mineral oil is used, making it insensitive to temperature changes. Oil is introduced through one of the two filler plugs *u*, *Fig.* 1, and the blades are completely submerged during operation. Oil leakage into the transmission is prevented by the bellows *o* and the Welsh plug *v* at the front of the runner hub.

On level terrain, it is possible to start from rest with the transmission in "high" by merely pressing on the accelerator pedal. The engine has sufficient torque to propel the car and one could do likewise with a friction clutch if one could engage it gradually enough

(*Concluded on Page* 38)

Scanning THE FIELD FOR Ideas

Measures Thickness from One Side

LONG a problem, the accurate determination of wall thickness of boiler tubes, ship's hull plates, tank cars and castings of various shapes is possible with equipment recently developed in England.

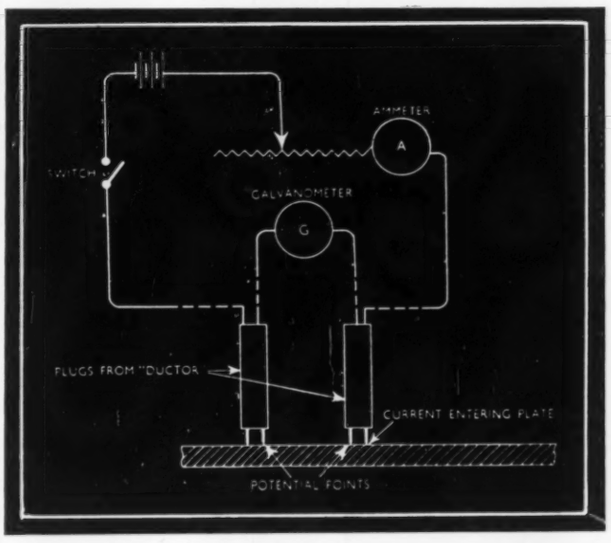


Fig. 1—This arrangement is used in measuring thickness of metals by their conductivity

By suitable calibration, thickness of any metal can be measured accurately even if access can be had only to one side. Present equipment measures thickness of mild steel plate up to 1¼ inches and castings up to 3 inches and is capable of an accuracy within a few thousandths of an inch. Already it has been valuable in measuring engine cylinder walls to detect core shift.

According to B. M. Thornton, Imperial Chemical Industries Ltd., Northwich, Cheshire, England, in a recent paper presented before the (British) Institution of Mechanical Engineers, four spring-loaded electrical contacts are used in the device shown in *Fig.* 1. A. storage battery furnishes 20 to 30 amperes of current which is passed between the outer two contacts. The voltage drop, of the order of 50 microvolts, produced in the material under study is measured between the two inner contacts by a sensitive electrical instrument.

Surface of material may be prepared for measurement by a number of methods. One is to center punch into the metal using a multiple-point punch spaced accurately to fit the measuring instrument contact arrangement. Another is to use clamps to force the contacts through whatever scale or dirt may be present. Some designs employ magnets to hold the contacts to the surface.

The system offers considerable possibilities in obtaining accurate thickness measurements formerly impossible due to inaccessibility or shape of the article. It has sufficient precision to indicate regions thinned by corrosion and so appears particularly valuable in checking for redesign, etc.

Tires Are Hollow Steel Floats

AN EXCELLENT example of the combination of light structural sections by welding to accomplish a dual purpose is seen in the "marsh buggy," illustrated in the accompanying view. Here welding is employed not only to fasten structural parts together but to provide airtight joints in the huge wheels which thereby are enabled to act as floats, carrying the unit easily over water, marsh and swamplands.

The unit shown, built by the Stanolind Oil & Gas Co., is capable of transporting a 6000-pound load over

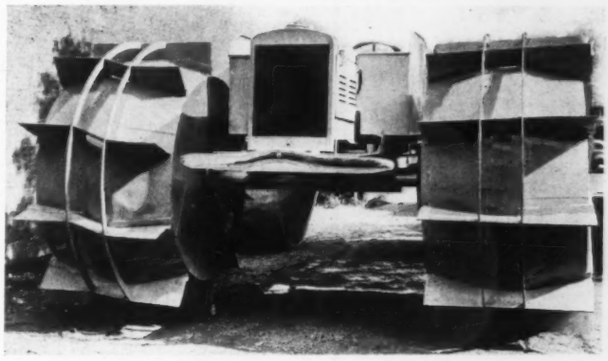


Fig. 2—Of welded steel with hollow wheels for floats, this marsh buggy carries 6000 pounds on water

water or highway. Special wheels are 7 feet in diameter and 4 feet wide, and being airtight float the 10,000-pound buggy easily. Complete marsh buggy is 21 feet long and 15 feet wide. It is powered with a Lincoln Zephyr engine which gives an operating speed of 2 miles per hour in water, 7 miles per hour in marsh and 12 miles on the highway.

Progressive Forging Field Enlarged

SAID to make available the largest physical force controlled by man for useful work, the hammer shown in accompanying illustration employs a 50,000-pound piston. With the top die, the reciprocating weight increases to more than 70,000 pounds. Driven by air, the hammer has a delicate control making it suitable for all types of forging work.

The unit is capable of being used with progressive dies where the full force of the hammer can be applied at one edge of the dies without damaging the machine, thus greatly enlarging the scope of progressive forging work that can be handled in present equipment.

Diameter of cylinder is 39 inches, stroke of piston 72 inches. For one class of work, maximum die area will be 24 x 120 inches. On other work, maximum die face will be 50 inches square. Hammer is double-acting; that is, air is admitted above the piston to drive ram at high velocity as well as to lift ram to top or striking position.

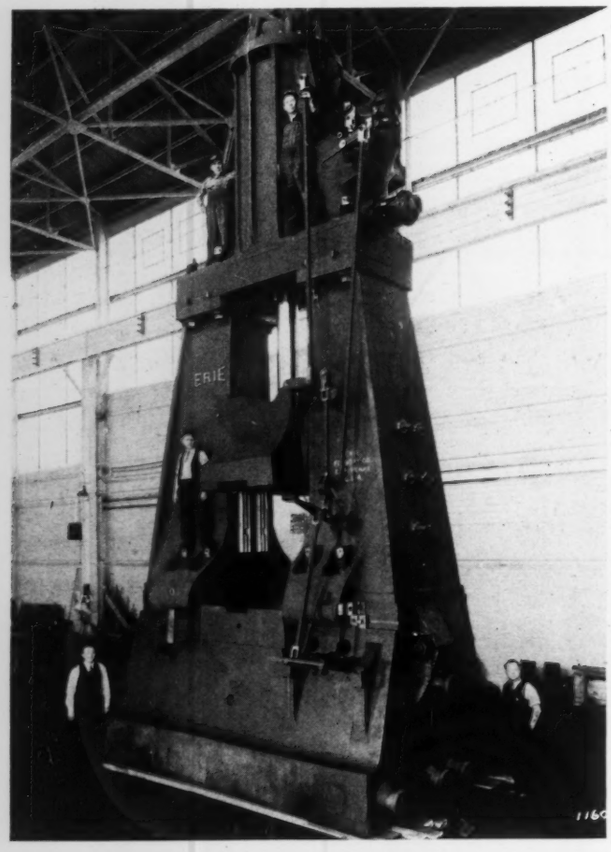


Fig. 3—When installed, this huge forging hammer will extend 27 feet above floor and 12 feet below

Fig. 4—Compact, beautifully housed timer will handle up to 15 amperes

Built by Erie Foundry Co., the hammer is to be shipped to England where it will be used in forging airplane propellors and crankcases of radial-type air plane engines.

Timer Permits Absentee Control

A SELF-STARTING self-lubricating synchronous electric motor in a molded black bakelite case with an "off" switch and an "on" switch having silver contacts constitutes a new timer, see *Fig.* 4, which turns any electric device on *and* off or on *or* off at any time previously determined. It does both operations with one setting of the dials. Current-carrying capacity is 15 amperes, making it capable of handling various types of electric appliances. It also is suitable for laboratory apparatus where it enables full control of operations without attendance. Made by American Timer Corp., the unit is known as the Sentinel timer.

Plastics Assure Permanent Legibility

FREQUENTLY it is desirable to label or number certain parts of machines so they may have a high degree of legibility. Furthermore, the most important factor may be that they retain their easy readability and original attractiveness for a long period of years.

Recently a manufacturer of a counting machine, employing wheels which formerly carried a strip with numbers embossed upon it, found that the double injection method of molding offered great possibilities in making this part of two contrasting plastics. In this method, the molding of the main part of the counting wheel in either black or white plastic is done with a die so constructed as to leave the numbers in the periphery open. Then the wheel is subjected to another molding process during which a material contrasting in color with the first material is injected through the openings to produce all of the figures. The periphery then forms a background for these letters or numbers. The result is a counting machine wheel having numbers that will never wear away and which are flat with the periphery of the wheel, a desirable feature.

Furthermore, the numbers may be made with a transparent or translucent plastic, permitting light to shine through giving a most effective counting device.

The counting machine in which the above wheel is used is made by the F. B. Redington Co., Chicago. Wheels are of Tenite, molded by the Gits Molding Corp., Chicago. This design received honorable mention in the scientific group of the third annual modern plastics competition sponsored by *Modern Plastics*.

Shear Pin Replaced by Relay

AN IMPORTANT change in shifting overload protection from mechanical to electrical means was made when Link-Belt Co. recently redesigned its line of automatic coal stokers for residential heating. The idea was to permit the motor to function under short periods of overload during which a large number of pieces possibly jammed in the feed-screw mechanism could be broken free. Such overload normally would cause a shear pin to break and shut down the stoker if that method of protection were used.

Using a thermal overload relay, protection is provided in case the motor is stalled and also in event there is a prolonged heavy overload. Mechanism driving the feed screw is made sufficiently strong to withstand any force the motor may exert.

Automatically Controls Belt Tension

MINIMUM TOTAL belt tension commensurate with load being handled has been the aim of belt conveyor designers for some time. A recent development outstanding in this respect affords compactness and considerable flexibility in conveyor layout yet assures the minimum belt tension necessary to handle the load being carried.

As shown in the accompanying illustration, the power drive unit with its motor and gear reducer or variable speed transmission is pivoted at one end so the weight of the drive itself acts to maintain belt tension at the desired value. This is said to afford a positive means of securing maximum effective tension with minimum total tension on the belt and gives the drive its name, "floating drive."

Necessity of a conventional take-up used in conjunction with head and tail end construction is eliminated, therefore no space is wasted at either end of a conveyor using this drive. The conveyor also can be connected closely to machines, production equipment, work tables, fixtures or other conveyors. Where packages transfer at right angles, from one belt to another, the terminal structure is compact. The drive makes use of only a few working parts—a single drive pulley directly connected to a gearhead motor, or individual speed reducer coupled to the motor. Two idler pulleys are employed, one to secure maximum belt wrap around the driven pulley, and the other to act as a means of automatically securing the correct amount of take-up and belt tension.

Tests indicate average belt tension is reduced 30 to 40 per cent with this type of drive. Unless the conveyor is loaded, the belt remains at minimum tension.

Alloys Solve "Impossible" Problems

Comparatively new to industry, the Wilcox-Rich alloys combine high hardness with abrasion and corrosion resistance and already are used in cylinder liners, draw dies, sleeves, packing glands, etc.

Most efficient and economical method of application of these alloys in terms of both material and time is probably the centrifugal casting or fusing process, patented by Wilcox-Rich and employing a highly developed technique. These alloys have an important advantage in that they form a perfect homogeneous bond with the base metal, it is claimed.

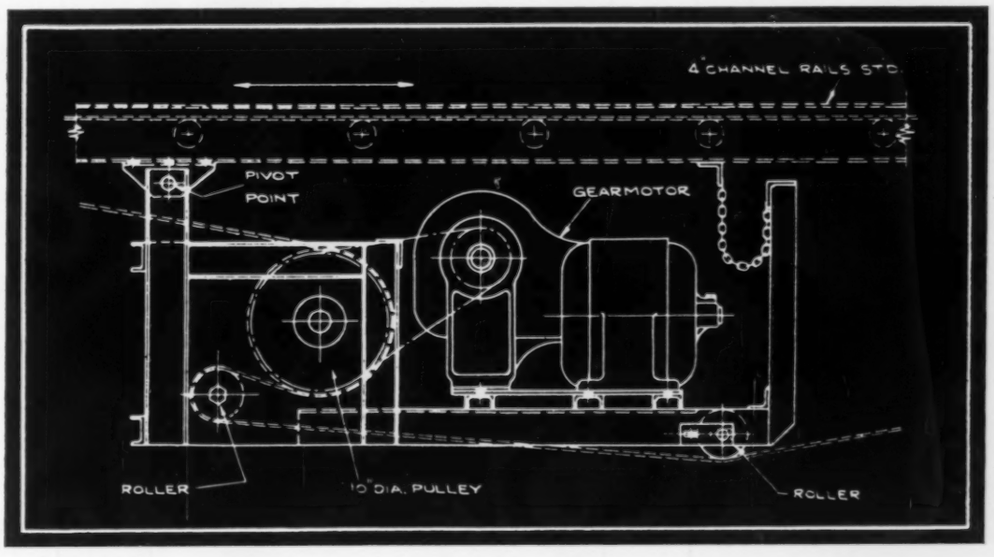


Fig. 5—Weight of the power or driving unit is used to control tension of belt conveyor

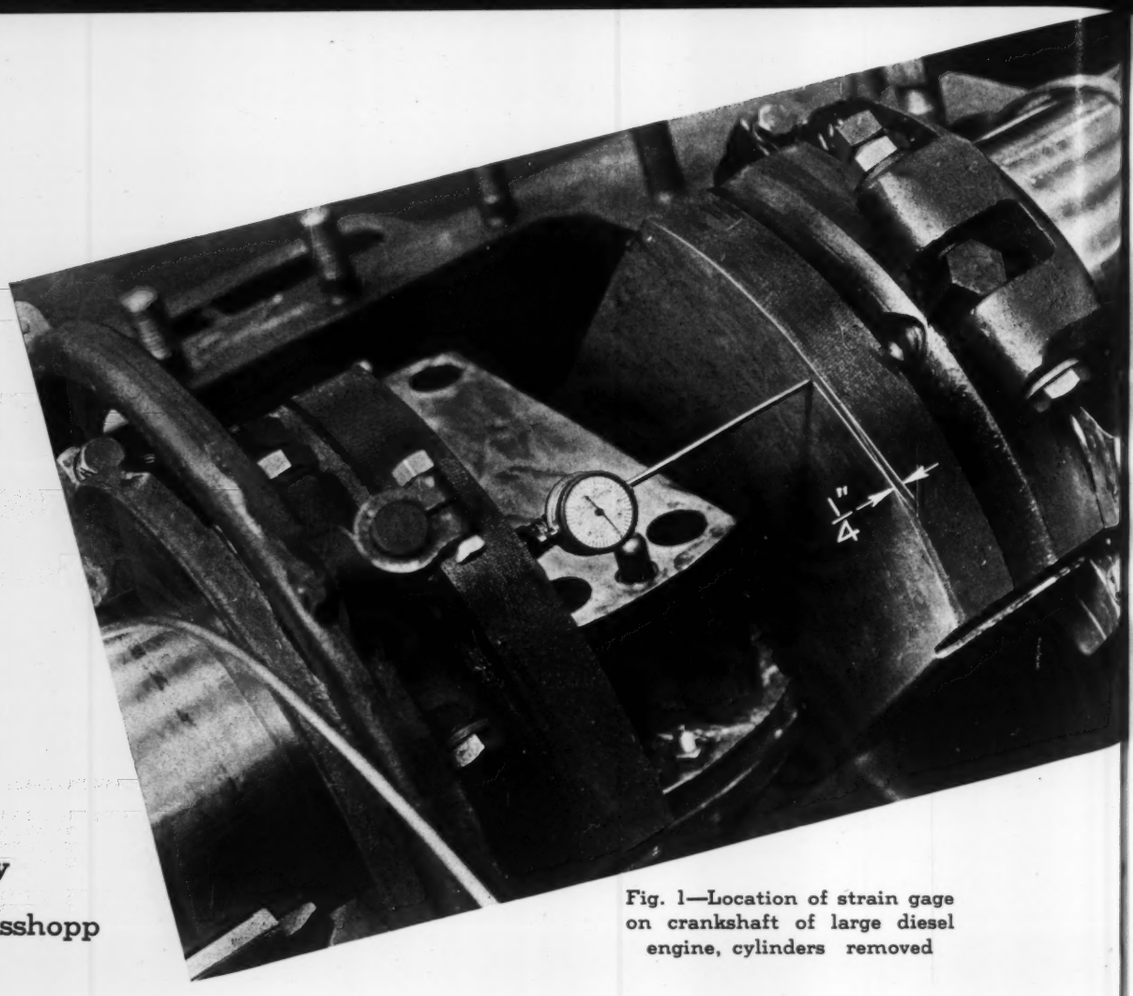


Fig. 1—Location of strain gage on crankshaft of large diesel engine, cylinders removed

By

K. E. Bisshopp

Calculating Stresses in Crankshafts from Strain Gage Readings

IN ORDER to establish permissible limits in crankshaft alignment problems where the strain gage is used, readings should be capable of interpretation in terms of stresses in the critical sections. This applies to installations like *Fig.* 3 where it is not possible to reduce the distortion between a pair of crank webs to zero. In cases like *Fig.* 2 it is frequently desirable to know the stresses resulting from a given amount of distortion indicated by the strain gage.

The alignment of an engine crankshaft with driven machinery shafting is usually accomplished by reducing strain gage readings at the last crank to zero. If the engine bearings are in line, the distortion in most cases is greatest in the crank at the power take-off end of the engine. Shims are placed under the engine or the position of the outboard bearings is adjusted until the strain gage readings are a minimum for the two horizontal and two vertical positions of the crank throws. *Fig.* 1 shows the location of the strain gage on the crankshaft of a large diesel engine with cylinders removed for the purpose of illustration.

There are two common types of installations shown in *Figs.* 2 and 3 on which this device is used frequently. The first type embodies a single outboard bearing and extension shaft where alignment is obtained by raising the outboard bearing until the strain gage shows no distortion in the end crank when it is rotated from top dead center (T.D.C.) to bottom dead center (B.D.C.).

The second type is the familiar two-bearing extension shaft which is used whenever there is a flexible coupling between the engine and driven machinery. Alignment is secured in this case by adjusting the position of the extension shaft bearings until the coupling faces are parallel and their centers run true. Under these conditions no transverse shearing force is transmitted by the coupling and the distortion between the crank webs is caused

entirely by the overhung weights between the engine and coupling, provided the engine bearings are in line. If a solid coupling is used with a two bearing extension shaft the same procedure is followed as with the single bearing extension shaft.

The following analysis gives a theoretical formula* for the maximum bending stress in the end crank web involving the crankshaft dimensions, the number of cylinders and the strain gage reading. The value of Δ used in this formula is the total distortion between the webs indicated by the strain gage when the crank is rotated from T.D.C. to B.D.C.

By referring to *Fig.* 4, the assumptions made in deriving a stress formula are seen to be (1) that the crankshaft is simply supported at the middle cross sections of the journals; (2) the throw is considered as a bar whose cross sectional dimension is small in comparison with the lengths a, h, and R; (3) that the extension between points A and B produced by arbitrary moments M_1 and M_2 is due to the flexibility of the crankpin over a length h and the flexure of the webs by constant bending moments.

Bending moment at any point x is

$$M_x = M_1 - (M_1 - M_2)x/l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The angle made by the tangent to the elastic line of the crankpin with its axis at $x = a$ is

$$i_a = \frac{M_a h}{3 E I'} + \frac{M_{l-a} h}{6 E I'} \text{ **}$$

$$= \frac{[M_1 l + (M_2 - M_1)a]h}{3 E I' l} + \frac{[M_2 l - (M_2 - M_1)a]h}{6 E I' l} \ldots (2)$$

The corresponding angle at $x = l - a$ is

$$i_{l-a} = \frac{M_a h}{6 E I'} + \frac{M_{l-a} h}{3 E I'}$$

$$= \frac{[M_1 l + (M_2 - M_1)a]h}{6 E I' l} + \frac{[M_2 l - (M_2 - M_1)a]h}{3 E I' l}$$

If $\Delta/2$ is the extension between the crank webs measured on the journal axis, then

$$\frac{\Delta}{2} = R(i_a + i_{l-a}) = \frac{M_1 + M_2}{2 E I'} R h \quad \ldots\ldots (3)$$

The crank which is shown in the T.D.C. position in *Fig.* 4 is contracted $\Delta/2$ between the webs by the moments M_1 and M_2 when it is rotated into the B.D.C. position so that the total distortion measured by the strain gage is

$$\Delta = (M_1 + M_2) \frac{R h}{E I'} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The webs are bent into circular arcs whose radii of curvature are EI_o/M_a and EI_o/M_{l-a}. Let the angles subtended by these arcs be $2i'_a$ and $2i'_{l-a}$. Then

$$i'_a = M_a R/2 EI_o \text{ and } i'_{l-a} = M_{l-a} R/2 EI_o \quad \ldots\ldots\ldots (5)$$

The extension between the crank webs measured on the journal axis is

$$\frac{\Delta}{2} = R(i'_a + i'_{l-a}) = (M_a + M_{l-a})R^2/2 EI_o$$
$$= (M_1 + M_2)R^2/2 EI_o \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Equations (4) and (6) give the total distortion between the webs as

$$\Delta = \frac{(M_1 + M_2)R}{E I'} \left[h + \frac{R I'}{I_o} \right] \ldots\ldots\ldots (7)$$

where M_1 and M_2 are arbitrary. It can be shown from geometrical considerations that if p is the distance from the crankpin axis to the axis of the strain gage,

$$\Delta_p = \frac{(M_1 + M_2)R}{E I'} \left[p \frac{h}{R} + (2p - R) \frac{I'}{I_o} \right] \ldots\ldots (8)$$

The strain gage is always placed in the plane which passes through the crankpin and journal axes. When the distortion is measured on the journal axis $p = R$ and Equation (8) reduces to (7).

Equations (7) and (8) can be used to obtain M_1

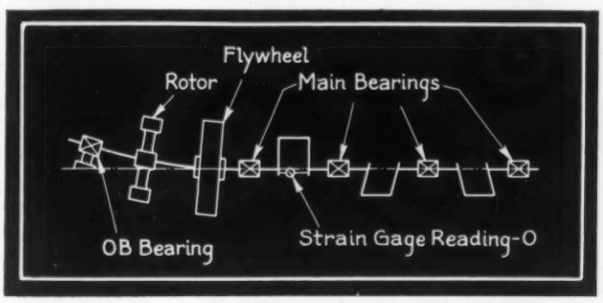


Fig. 2—Single outboard bearing and extension shaft where alignment is obtained by raising outboard bearing until strain gage shows no distortion

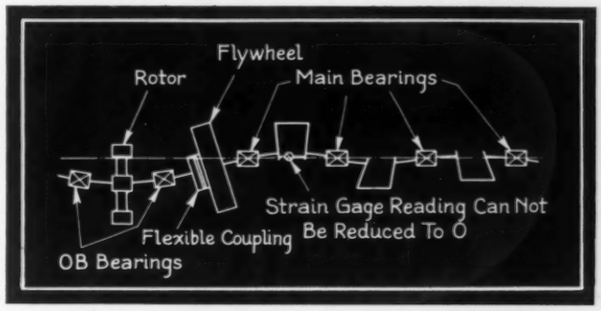


Fig. 3—Two-bearing extension shaft where alignment is secured by adjusting the position of the extension shaft bearings until coupling faces are parallel

* See Equation 16. For the direct solution of practical cases, average values from Tables I and II may be used. Solutions of sample problems are given on page 33.

** Timoshenko, *Strength of Materials*, Vol. 1, First edition, 1930, page 163.

and M_2 when their ratio is known which makes it possible to find the stresses from the strain gage reading. The ratio M_2/M_1 cannot be determined in general without additional information, but if the engine bearings are assumed in line this factor can be calculated for each crank for any number of

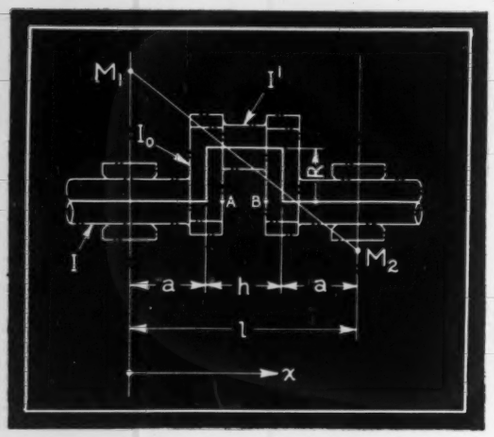


Fig. 4—Diagram illustrating steps in arriving at formula for maximum bending stress in end crank web, involving crankshaft dimensions, number of cylinders, strain gage reading

cylinders. This calculation will be made for the crank at the power take-off end of the engine since the stresses produced by misalignment with driven machinery or by overhung weights usually are greatest in this crank.

Strain Gage Not Infallible

If the crankshaft bearings are not in line M_1 and M_2 can have any finite values, in particular $M_1 = -M_2$ and $\Delta = 0$ which could be the case with every other journal bearing high or low an equal amount. This shows that the strain gage is not an infallible indicator of crankshaft alignment between consecutive journal bearings since it gives a zero reading whenever the crank is on an inflection point of the elastic curve. The strain gage, however, is not used primarily for aligning engine bearings, but for aligning driven machinery shafting, to which cases the following analysis proceeding from Equations (7) and (8) is directly applicable.

The stress in the crank web nearest to the power take-off end of the engine is calculated as follows: Bending moment at $x = a$ is

$$M_a = M_1 + (M_2 - M_1)a/l$$

Let $M_2 = -K_n M_1$ where K_n is a constant depending on the number of cylinders (n).

$$M_a = M_1[1 - (1 + K_n)a/l] \quad \ldots\ldots\ldots\ldots (9)$$

From Equations (7) and (9)

$$M_1 = \frac{E I_o \Delta}{R(1 - K_n)(h I_o/I' + R)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$M_a = \frac{E I_o \Delta [1 - (1 + K_n)a/l]}{R(1 - K_n)\left(h \frac{I_o}{I'} + R\right)} \quad \ldots\ldots\ldots\ldots (11)$$

The bending stress in the web is $M_a t/2l_a$

$$S = \frac{E t \Delta [1 - (1 + K_n)a/l]}{2R(1 - K_n)\left(h \frac{I_o}{I'} + R\right)} \quad \ldots\ldots\ldots\ldots (12)$$

where Δ is measured on the journal axis.

If the distortion is measured at a distance p from the crankpin axis, Equation (8) applies and

$$S = \frac{E t \Delta_p [1 - (1 + K_n)a/l]}{2R(1 - K_n)\left(h \frac{I_o}{I'} + R\right)} \times \left[\frac{h + R\frac{I'}{I_o}}{p\frac{h}{R} + (2p - R)\frac{I'}{I_o}}\right] \ldots (13)$$

This equation may be simplified by separating the factors which depend on n from those which do not. Let

$$C_n = \frac{1 - (1 + K_n)a/l}{2(1 - K_n)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

The strain gage is usually placed about ¼-inch (*Fig.* 1) from the bottom of the web in the plane which contains the crankpin and journal axes. This fixes p and makes the second factor in Equation (13) a

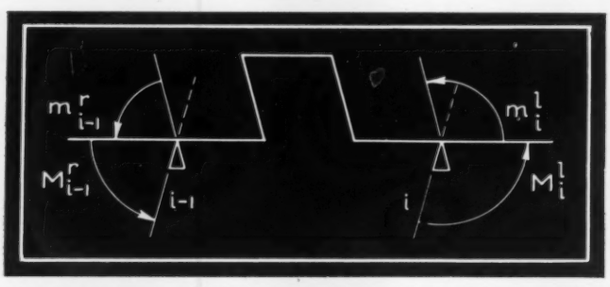


Fig. 5—Relation of positive moments acting on a single throw

constant which depends only on the crankshaft dimensions. Let

$$C_o = \frac{h + R\frac{I'}{I_o}}{p\frac{h}{R} + (2p - R)\frac{I'}{I_o}} \quad \ldots\ldots\ldots\ldots\ldots (15)$$

Equation (13) now becomes

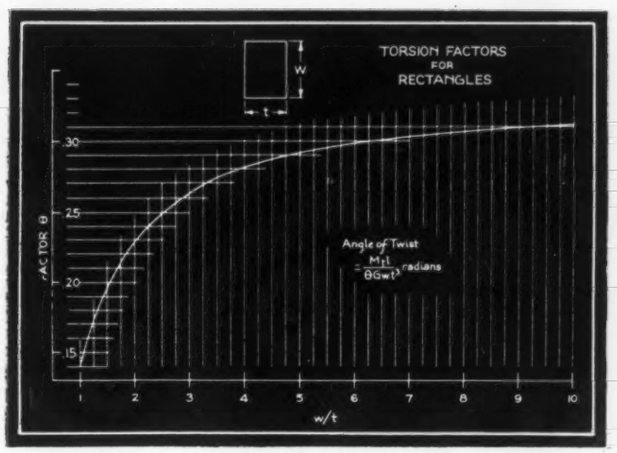


Fig. 6—A curve for theta. Factors are taken from "Applied Elasticity"

$$S^{\dagger} = \frac{C_o\, C_n\, E\, t\, \Delta_p}{R\left(h\frac{I_o}{I'} + R\right)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

The values of K_n and C_n are calculated from the theory of bending of a crankshaft by a couple applied at one end using the same assumptions that were made for the single crank. The symbols are changed to conform with those used by Timoshenko in the analysis of this problem.††

Bending moments in the planes of the throws on the right and left of the $i\,th$ support are denoted by $m^r{}_i$ and $m^l{}_i$; the moments in planes perpendicular to the planes of the throws by $M^r{}_i$ and $M^l{}_i$. The angle between the planes of the crank throws adjacent to the $i\,th$ support is denoted by γ_i. The condition that the resultant bending moments are equal and opposite on either side of the $i\,th$ support is

$$\left.\begin{aligned} M^l{}_i + M^r{}_i \cos\gamma_i - m^r{}_i \sin\gamma_i &= 0 \\ m^l{}_i + M^r{}_i \sin\gamma_i + m^r{}_i \cos\gamma_i &= 0 \end{aligned}\right\} \ldots\ldots\ldots (17)$$

Fig. 5 shows the relation of positive moments acting on a single throw. The angles made by the tangents to the elastic line with the crankshaft axis in the planes of the throws on the right and left of the $i\,th$ support are denoted by $\phi^r{}_i$ and $\phi^l{}_i$; the angles in planes perpendicular to the planes of the throws by $\psi^r{}_i$ and $\psi^l{}_i$. The relations between the moments $m^r{}_i$, $m^l{}_i$, $M^r{}_i$, $M^l{}_i$ and $\phi^r{}_i$, $\phi^l{}_i$, $\psi^r{}_i$, $\psi^l{}_i$ are

$$\left.\begin{aligned} \phi^l{}_i &= m^l{}_i\,\alpha_1 - m^r{}_{i-1}\,\alpha_2 \\ \phi^r{}_i &= m^r{}_i\,\alpha_1 - m^l{}_{i+1}\,\alpha_2 \\ \psi^l{}_i - M^l{}_i\,\beta_1 - M^r{}_{i-1}\,\beta_2 \\ \psi^r{}_i &= M^r{}_i\,\beta_1 - M^l{}_{i+1}\,\beta_2 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots (18)$$

where

$$\frac{E\,I\,\alpha_1}{R} = \left[\left(\frac{a}{l}\right)^2\frac{I}{I_o} + \left(\frac{a+h}{l}\right)^2\frac{I}{I_o} + \frac{l}{3R} + \frac{6\,a^2h + 6\,ah^2 + 2\,h^3}{6\,Rl^2}\left(\frac{I}{I'} - 1\right)\right] \ldots (19)$$

$$\frac{E\,I\,\alpha_2}{R} = \left[\frac{a(h+l)}{l^2}\frac{I}{I_o} + \frac{l}{6R} + \frac{6\,a^2h + 6\,ah^2 + h^3}{6\,R\,l^2}\left(\frac{I}{I'} - 1\right)\right] \ldots (20)$$

$$\frac{E\,I\,\beta_1}{R} = \left[\frac{\left(\frac{E}{G}\right)\left(\frac{a}{l}\right)^2\frac{I}{I_o}}{12\,\Theta} + \frac{\left(\frac{E}{G}\right)\left(\frac{a+h}{l}\right)^2\frac{I}{I_o}}{12\,\Theta} + \frac{l}{3\,R} + \frac{6\,a^2h + 6\,ah^2 + 2\,h^3}{6\,Rl^2}\left(\frac{I}{I'} - 1\right) + \frac{2}{3}\left(\frac{I}{I_1}\right)\left(\frac{R}{l}\right)^2 + \frac{E}{2G}\left(\frac{I}{I'}\right)\left(\frac{hR}{l^2}\right)\right] \ldots (21)$$

$$\frac{E\,I\,\beta_2}{R} = \left[\frac{E}{G}\,\frac{a(h+l)}{12\,\Theta\,l^2}\,\frac{I}{I_o} + \frac{l}{6\,R} + \frac{6\,a^2h + 6\,ah^2 + h^3}{6\,R\,l^2}\left(\frac{I}{I'} - 1\right) - \frac{2}{3}\left(\frac{I}{I_1}\right)\left(\frac{R}{l}\right)^2 - \frac{E}{2\,G}\left(\frac{I}{I'}\right)\left(\frac{h\,R}{l^2}\right)\right] \ldots\ldots\ldots\ldots (22)$$

A curve for θ is shown in *Fig.* 6.

Two relations involving the ϕ's and ψ's are obtained from the continuity of the elastic line at any support.

$$\left.\begin{aligned} \phi^l{}_i &= \phi^r{}_i \cos\gamma_i + \psi^r{}_i \sin\gamma_i \\ \psi^l{}_i &= -\phi^r{}_i \sin\gamma_i + \psi^r{}_i \cos\gamma_i \end{aligned}\right\} \ldots\ldots\ldots\ldots (23)$$

† Constants for this equation are given in Tables I and II.
†† Timoshenko & Lessels, *Applied Elasticity*, pp. 188-209.

TABLE I

Bore & Stroke			180° Crank Interval		90° Crank Interval		2 or 4-Cycle		2-Cycle		4-Cycle		2 or 4-Cycle	
	K_1	C_1	K_2	C_2	K_2	C_2	K_3	C_3	K_4	C_4	K_4	C_4	K_5	C_5
6 x 6½	0	.3670	.2929	.4640	.2938	.4644	.3129	.4736	.3222	.4783	.3233	.4788	.3187	.4765
8¾ x 10½	0	.3646	.2994	.4625	.3009	.4632	.3205	.4727	.3309	.4779	.3321	.4785	.3274	.4761
10 x 12½	0	.3708	.2870	.4680	.2847	.4669	.3017	.4751	.3138	.4812	.3152	.4820	.3103	.4794
10½ x 12½	0	.3688	.2891	.4653	.2900	.4658	.3075	.4742	.3171	.4790	.3181	.4796	.3135	.4772
12 x 15	0	.3427	.3270	.4327	.3253	.4320	.3553	.4448	.3694	.4513	.3714	.4522	.3667	.4500
12 x 15	0	.3648	.2953	.4610	.2955	.4611	.3142	.4700	.3252	.4755	.3265	.4761	.3217	.4737
14 x 17	0	.3419	.3191	.4279	.3196	.4282	.3476	.4397	.3586	.4445	.3598	.4451	.3557	.4433
14 x 17	0	.3682	.2908	.4652	.2908	.4652	.3088	.4739	.3192	.4791	.3204	.4797	.3157	.4773
14 x 17	0	.3419	.3284	.4317	.3373	.4354	.3667	.4482	.3732	.4513	.3735	.4514	.3705	.4500
14 x 17	0	.3650	.3001	.4636	.3057	.4662	.3257	.4761	.3324	.4794	.3330	.4798	.3289	.4777
16 x 20	0	.3682	.2920	.4658	.2911	.4653	.3093	.4741	.3207	.4798	.3220	.4805	.3172	.4781
16 x 20	0	.3682	.2961	.4677	.3018	.4704	.3202	.4796	.3270	.4831	.3276	.4834	.3235	.4813
Average	0	.3610	.3014	.4563	.3030	.4570	.3242	.4668	.3341	.4717	.3353	.4723	.3308	.4700

Eight-cylinder, 2 or 4-cycle, $K_8 = .3189$; $C_8 = .4719$ calculated for 8¾ x 10½ engine

TABLE II

Bore & Stroke	I′	h	I_o/I'	t	$EI\alpha_1/R$	$EI\alpha_2/R$	$EI\beta_1/R$	$EI\beta_2/R$	C_o
6 x 6½	7.366	5.031	.3526	1.9062	2.8310	1.6586	2.8143	1.3019	.5128
8¾ x 10½	30.68	7.219	.3309	2.6562	2.8285	1.6936	2.8000	1.2922	.5424
10 x 12½	63.62	8.938	.4029	3.375	2.5175	1.4448	2.5569	1.0784	.5312
10½ x 12½	135.62	9.500	.3932	4.000	2.6250	1.5179	2.6092	1.1544	.4980
12 x 15	117.86	10.750	.4673	4.188	3.0119	1.9695	3.0418	1.6619	.5397
12 x 15	201.06	10.562	.3984	4.438	2.5420	1.5015	2.5399	1.1379	.5110
14 x 17	201.06	12.125	.3937	4.562	2.7358	1.7458	2.7266	1.4856	.5352
14 x 17	322.1	12.531	.3809	4.969	2.6455	1.5388	2.6463	1.1737	.5089
14 x 17	322.1	12.125	.2949	4.562	3.2185	2.1137	3.0476	1.7332	.4994
14 x 17	322.1	12.188	.2949	4.562	3.0934	1.8565	2.9805	1.4180	.4996
16 x 20	490.1	14.188	.3672	5.500	2.6663	1.5572	2.6833	1.1814	.5347
16 x 20	718.7	14.188	.2797	5.500	3.1872	1.8877	3.0681	1.4256	.5145
								Average =	.5190

Equations (17), (18) and (23) combine to give

$$\left.\begin{aligned} m^l_i\,\alpha_1 - m^r_{i-1}\,\alpha_2 &= (m^r_i\alpha_1 - m^l_{i+1}\,\alpha_2)\cos\gamma_i \\ &\quad + (M^r_i\,\beta_1 - M^l_{i+1}\,\beta_2)\sin\gamma_i \\ M^l_i\,\beta_1 - M^r_{i-1}\,\beta_2 &= (M^r_i\,\beta_1 - M^l_{i+1}\,\beta_2)\cos\gamma_i \\ &\quad - (m^r_i\alpha_1 - m^l_{i+1}\,\alpha_2)\sin\gamma_i \end{aligned}\right\} \quad \ldots (24)$$

These equations are used for multithrow crankshafts in the same way as Clapeyron's equations for continuous beams.

Equations like (17) give

$$\left.\begin{aligned} M^r_i &= -\frac{m^l_i + m^r_i\cos\gamma_i}{\sin\gamma_i}; \\ M^r_{i-1} &= -\frac{m^l_{i-1} + m^r_{i-1}\cos\gamma_{i-1}}{\sin\gamma_{i-1}}; \\ M^l_i &= \frac{m^r_i + m^l_i\cos\gamma_i}{\sin\gamma_i};\quad M^l_{i+1} = \frac{m^r_{i+1} + m^l_{i+1}\cos\gamma_{i+1}}{\sin\gamma_{i+1}} \end{aligned}\right\} \quad (25)$$

Equations (24) are transformed by equations (25) except when $\gamma_i = 0$ or π to give

$$\left.\begin{aligned} &-\alpha_2\,m^r_{i-1} + (\alpha_1+\beta_1)m^l_i - (\alpha_1-\beta_1)\cos\gamma_i\,m^r_i \\ &\quad + \left\{\alpha_2\cos\gamma_i + \frac{\beta_2\sin\gamma_i\cos\gamma_{i+1}}{\sin\gamma_{i+1}}\right\} m^l_{i+1} \\ &\quad + \beta_2\frac{\sin\gamma_i}{\sin\gamma_{i+1}}m^r_{i+1} = 0 \\ &\frac{\beta_2}{\sin\gamma_{i-1}}\,m^l_{i-1} + \beta_2\cot\gamma_{i-1}\,m^r_{i-1} + 2\,\beta_1\cot\gamma_i\,m^l_i \\ &\quad + \left\{\frac{\beta_2}{\sin\gamma_i} + \frac{\beta_1\cos^2\gamma_i}{\sin\gamma_i} + \alpha_1\sin\gamma_i\right\} m^r_i \\ &\quad + \left\{\frac{\beta_2\cos\gamma_i\cos\gamma_{i+1}}{\sin\gamma_{i+1}} - \alpha_2\sin\gamma_i\right\} m^l_{i+1} \\ &\quad + \beta_2\frac{\cos\gamma_i}{\sin\gamma_{i+1}}m^r_{i+1} = 0 \end{aligned}\right\} \quad (26)$$

A solution is obtained by setting $m^l_1 = -m^r_1$ and $m^l_e = m^r_e = 0$ where m^l_e and m^r_e are the moments at the last bearing assumed freely supported. Since m^l_1 and m^r_1 are taken in the same plane, $\gamma_1 = 0$ and $\beta_2 m^l_1/\sin\gamma_1 + \beta_2\cot\gamma_1\,m^r_1 = 0$. The convention adopted for signs is equivalent to

$$M_1 = -m^r_1\ ;\ M_2 = m^l_2$$

so that

$$-M_2/M_1 = m^l_2/m^r_1 = K_n \quad \ldots (27)$$

M_1 and M_2 in this equation are moments in the plane of the throw. K_n is used in Equation (14) and can be calculated from a formula involving the α and β factors in a number of simple cases listed below.

(1) Two-cylinder crankshaft with 180 degrees crank interval

$$K_2 = \alpha_2/2\,\alpha_1 \quad \ldots (28)$$

(2) Two-cylinder crankshaft with 90 degrees crank interval

$$K_2 = \alpha_2/(\alpha_1+\beta_1) \quad \ldots (29)$$

(3) Four-cylinder 4-cycle crankshaft with all throws in one plane

$$K_4 = \frac{\alpha_2(4\,\alpha^2_1 - \alpha^2_2)}{4\,\alpha_1(2\,\alpha^2_1 - \alpha^2_2)} \quad \ldots (30)$$

LIST OF SYMBOLS

a = distance from center line of journal to middle of web (inches)
h = length of crank pin (inches)
l = cylinder spacing (inches)
M_1, M_2, M_x = bending moments
x = variable distance from journal center line
I' = rectangular moment of inertia of crankpin
I = rectangular moment of inertia of journal
I_o = rectangular moment of inertia of web = $Wt^3/12$
I_1 = rectangular moment of inertia of web = $W^3t/12$
W = width of web (inches)
t = thickness of web (inches)
D = crank pin diameter (inches)
Δ = distortion in inches
R = crank radius (inches)
i, i' = angles of tangents to elastic line at any point
p = distance from crank pin axis (inches)
K_n = ratio of bending moments
S = stress (pounds per square inch)
E = modulus of elasticity in tension = 30 x 10^6 (pounds per square inch)
G = modulus of elasticity in shear = 11.8 x 10^6 (pounds per square inch)
C_n = constant depending on n
C_o = constant depending on the crank shaft dimensions
M^l_i, M^r_i, m^l_i, m^r_i = bending moments at ith support
ϕ^l_i, ϕ^r_i, ψ^l_i, ψ^r_i = angles of tangents to elastic line at ith support
γ_i = angle between planes of successive crank throws
Θ = torsion factor for rectangles
α_1, α_2, β_1, β_2 = constants depending on crankshaft dimensions
n = number of cylinders

(4) Four-cylinder 2-cycle crankshaft. Crank sequence 1324

$$K_4 = \frac{2\,\alpha_2\,\beta_1\,(\alpha_1+\beta_1)-\alpha_2\,\beta^2_2}{2\,(\beta_1\,[2\,\alpha_1\,(\alpha_1+\beta_1)-\alpha^2_2]-\alpha_1\,\beta^2_2)} \quad \ldots\ldots\ldots (31)$$

Equations (26) to (31) inclusive together with Equation (14) were used to calculate the C_n and K_n (n= 1, 2, 3, 4, 5) values given in Table I. Equations (24) were used for the two and four-cycle eight-cylinder crankshafts. Crank sequence 14325 was used for the five-cylinder two or four-cycle crankshaft; 17354628 for the eight-cylinder two-cycle crankshaft; and (18), (27), (45), (36) for the eight-cylinder four-cycle crankshaft.

Values of α and β calculated from Equations (19) to (22) inclusive and C_o values calculated from Equation (15) are given in Table II, which also contains the values of h, I', I_o/I', and t.

Example 1. The distortion measured between the crank webs at the flywheel end of a four-cylinder, 14 x 17-inch, two-cycle engine installation like that shown in *Fig.* 3 was .005-inch. The bending stress in the web is found from Equation (16) using the proper constants from line 9 of Tables I and II.

$$S = \frac{.4994 \times .4513 \times 30 \times 10^6 \times 4.562 \times .005}{8.5\,(12.125 \times .2949 + 8.50)}$$
$$= 1500 \textit{ pounds per square inch.}$$

The stress in the journal is calculated from Equation (10)

$$S = \frac{10.186 \times 30 \times 10^6 \times 322.1 \times .2949 \times .4994 \times .005}{(9)^3 \times 8.5\,(1-.3732)\,(12.125 \times .2949 + 8.50)}$$
$$= 1545 \textit{ pounds per square inch.}$$

The flywheel weight was 6700 pounds with 18.625 inches overhang so that M_1=124,800 in. pounds. The calculated distortion is found from Equation (8).

$$\Delta_p = \frac{124{,}800\,(1-.3732)\times 8.5}{30\times 10^6 \times 322.1 \times .4994}\left[12.125 + \frac{8.5}{.2949}\right]$$

= .00564-inch which compares favorably with the strain gage reading.

Example 2. The distortion measured between the end crank webs of a five-cylinder 8¾ x 10½, two-cycle engine was .0065-inch which was produced by a 1000-pound flywheel with 15¾-inch overhang and a clutch, weighing 867 pounds with 23-inch overhang. The distortion is found from Equation (8) using the proper factors from line 2 of Tables I and II.

$$\Delta_p = \frac{(1000\times 15.75 + 867\times 23)\,(1-.3274)\times 5.25}{30\times 10^6 \times 30.68 \times .5424}$$
$$\times \left(7.22 + \frac{5.25}{.3309}\right) = .00582 \textit{ inches}$$

The bending stress in the end crank web is found from Equation (16).

$$S = \frac{.5424 \times .4761 \times 30 \times 10^6 \times 2.6562 \times .0065}{5.25\,(7.22 \times .3309 + 5.25)}$$
$$= 3335 \textit{ pounds per square inch.}$$

This stress is of opposite sign to that produced by the firing pressure at top dead center and would ordinarily be considered a moderate stress.

TABLE III

Bore and Stroke	Average C	$\frac{C_o Et \times 10^{-6}}{R(hI_o/I'+R)}$	$\frac{S \times 10^{-5}}{\Delta_p}$	Crankpin Dia. = D	$\frac{SD \times 10^{-3}}{\Delta_p}$
6 x 6½	.4731	1.7960	850	3.50	2975
8¾ x 10½	.4723	1.0778	509	5.00	2545
10 x 12½	.4759	.8736	416	6.00	2496
10½ x 12½	.4739	.9576	454	7.25	3292
12 x 15	.4447	.7219	321	7.00	2247
12 x 15	.4700	.7748	364	8.00	2912
14 x 17	.4388	.6492	285	8.00	2280
14 x 17	.4739	.6724	319	9.00	2871
14 x 17	.4453	.6659	297	9.00	2673
14 x 17	.4742	.6652	315	9.00	2835
16 x 20	.4744	.5801	275	10.00	2750
16 x 20	.4779	.6077	290	11.00	3190
				Average =	2756

An approximate formula for permissible distortion which involves bending stress in web and crankpin diameter can be obtained by using the average value of C_2, C_3, C_4, and C_5 for two-cycle engines in Equation (16). This calculation works out according to Table III.

For engines of two or more cylinders it is found that distortion ***

$$\Delta_p = \frac{SD\times 10^{-3}}{2756};\quad S = \frac{2756\Delta_p \times 10^3}{D}$$
$$\textit{pounds per square inch.} \quad \ldots\ldots\ldots (32)$$

Similarly for a single-cylinder engine

$$\Delta_p = \frac{SD\times 10^{-3}}{2134};\quad S = \frac{2134\Delta_p \times 10^3}{D}$$
$$\textit{pounds per square inch} \ldots\ldots\ldots\ldots (33)$$

It will be noted by comparison with the examples that in general formulas (32) and (33) give a good approximation to the stresses.

*** Δ_p is measured ¼-inch from bottom of web as shown in *Fig.* 1.

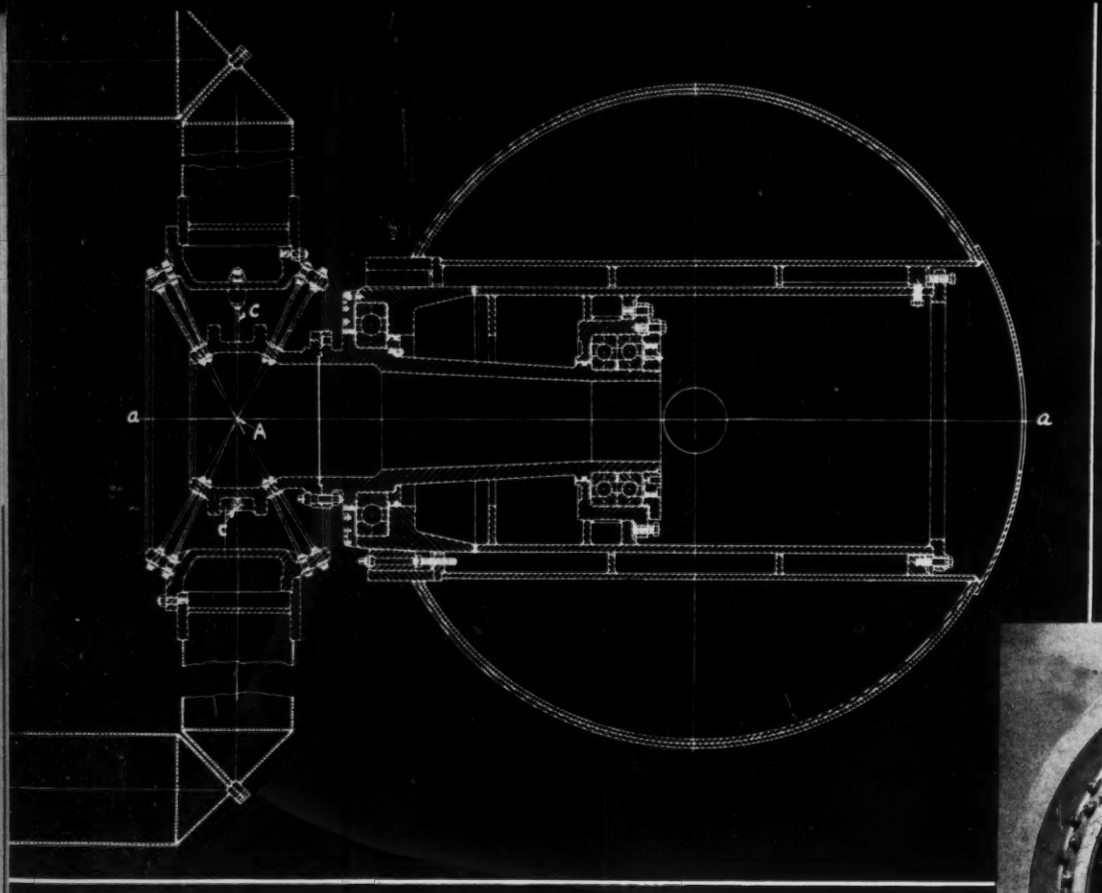
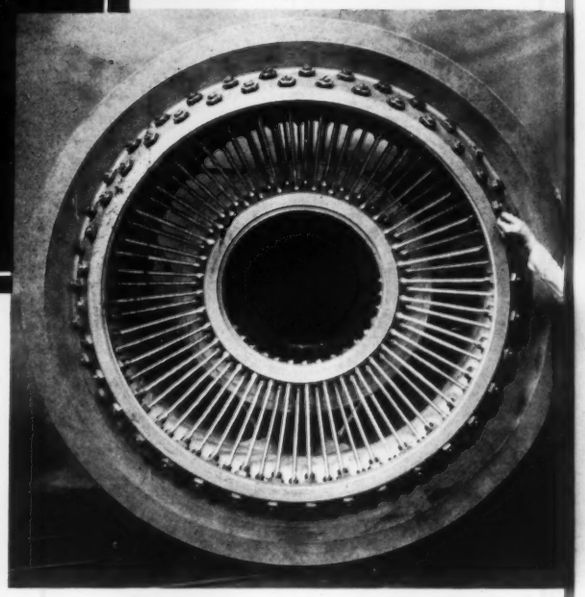


Fig. 1—Left—Arrangement of flexible spokes on two cones having a common apex, all spokes except torque spokes being prestressed

Fig. 2 — Below — A gimbal completely assembled, an example of a development of the "elastic hinge"



Elastic Hinge Principle Utilized in Telescope Mounting

By R. P. Kroon

Westinghouse Electric & Mfg. Co., South Philadelphia

MANY novel ideas are incorporated in the design of the 200-inch telescope which will be erected on Mt. Palomar, Calif., for the scientists of the California Institute of Technology. Work of manufacturing the huge structure has extended over a period of 2½ years. One of the most interesting design details is the flexible gimbal, or "bicycle wheel," used in the mounting of the telescope and discussed in this article.

The complete mounting is made of two main parts, the tube and the yoke, the function of the tube being to maintain proper alignment between the mirror and the other optical apparatus. The yoke guides the tube firmly on its path following the stars from East to West. For good operation, it is essential that inevitable distortions of the yoke, under its own weight and that of the tube, be transmitted as little as possible to the framework of the tube where they would upset the optical alignment. To insure this condition, couplings or gimbals are used between the yoke and the tube. Such gimbals, acting like spherical ball bearings, make it possible to treat the tube and the yoke as separate units which can be precalculated and tested by themselves. In this way the tube is virtually suspended at two points. *Fig.* 2 shows one of these gimbals completely assembled. Because of their shape, they were

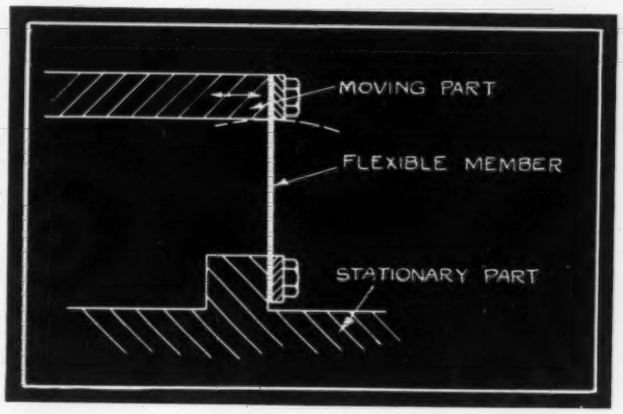


Fig. 3—Where approximately straight line motions are desired, one can simply use metal strips fastened to the stationary part at one end and to the moving part at the other

immediately referred to as "bicycle wheels." They are a development of the "elastic hinge" principle.

"Elastic hinges" in scientific instruments and other technical equipment have become prominent in recent years, the use of such members (consider, for instance, thin metal strips) being based on the principle that they can be bent easier than stretched.

As an example, take a cantilever strip .004 inch thick and 1 inch long. It can easily be calculated that the sidewise force necessary to produce a certain amount of lateral deflection at the free end will be only 1/250,000th as large as the lengthwise force which would give an elongation of equal amount. Such thin members, therefore, can be used as guides, since they allow practically only sidewise motion.

Where approximately straight line motions are desired, one can simply use strips fastened to the stationary part at one end and to the moving part at the other end, as in *Fig.* 3.

Advantages of such a construction are: (1) No lost motion; (2) no lubricant required; (3) no friction (except for small hysteresis forces in the strips).

The disadvantages are: (1) When the motions are large, they will deviate perceptibly from a straight line; (2) there is a definite limit as to how much motion the strip will stand permanently.

Two flexible members can be used where the motion of the moving part has to be a rotation about a fulcrum. *Fig.* 4 shows the customary design with two strips at right angles to each other. Hinge *a* will allow any rotating motion having its axis (perpendicular to the plane of the paper) in the plane of *a*. Hinge *b*, however, permits only motions which take place about an axis in the *b* plane. Therefore the only motion possible with both *a* and *b* functioning is a rotation about an axis through O, in which the two planes intersect. Point O is therefore the fulcrum.

To be physically possible, the hinges of *Fig.* 4 have to be side by side and several possibilities (one wide strip *a* between two narrow strips *b*, etc.) present themselves.

The flexible gimbals (*Fig.* 1) for the 200-inch telescope had to satisfy the following requirements: (a) Minimum resistance against rotary displacements about the fulcrum point *A;* (b) stiffness against linear displacements, to guide the telescope tube properly, and also against torque about the "declination axis" *a-a* since the bearing torque has to be supplied through the gimbals.

The arrangement of flexible members shown in *Fig.* 1 fulfills these requirements. The members, spokes in this case, are arranged on two cones having a common apex *A*. A special set of torque spokes *C* is required to furnish stiffness against torsional moments about the declination axis.

All spokes except the torque spokes are prestressed a specified amount, a simple instrument being used to facilitate this work. The instrument contains a thin rod which can be attached to the threaded end of the gimbal spoke with a nut. The thin rod and the spoke are then stretched by turning another nut fitting over the threaded end of the thin rod. Twisting of the thin rod and the spoke is eliminated by the use of a keyway in this threaded portion. The load on the rod and spoke is measured by means of an extensometer indicating the elongation of the thin rod. After the rod and the spoke have been stretched a sufficient amount, the regular nut at the end of the spoke is turned until the extensometer gauge shows a slight decrease, indicating that the nut is snug against the spot faced metal beneath. The instrument is then removed and put on the next spoke.

This procedure (the spokes were stretched in prescribed order) made possible a rapid prestressing of the spokes. However, due to deformation of the inner and outer gimbal ring, this first stretching gave only approximate results. For the final stretching, every individual spoke in turn was released completely, and then retightened by means of the instrument, another extensometer checking the exact stress in the spoke itself. No further tightening was necessary.

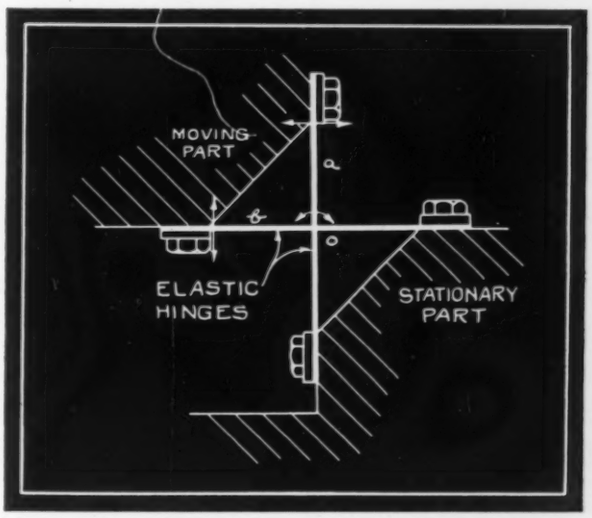


Fig. 4—Customary design of elastic hinge with two strips at right angles to each other

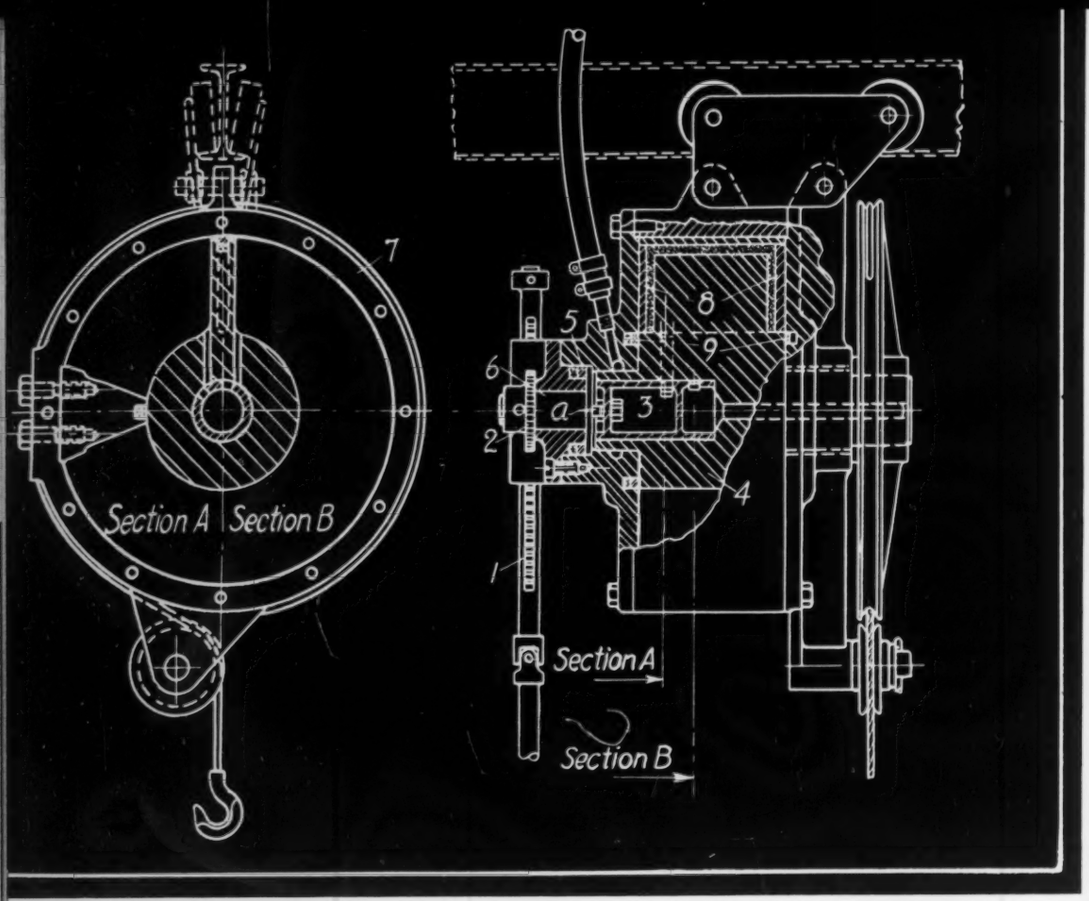


Fig. 1—A servo-motor used for a hoist, and adapted to transmit rotary motion directly

Pneumatic, Hydraulic Servo-Motors Reduce Operator's Load

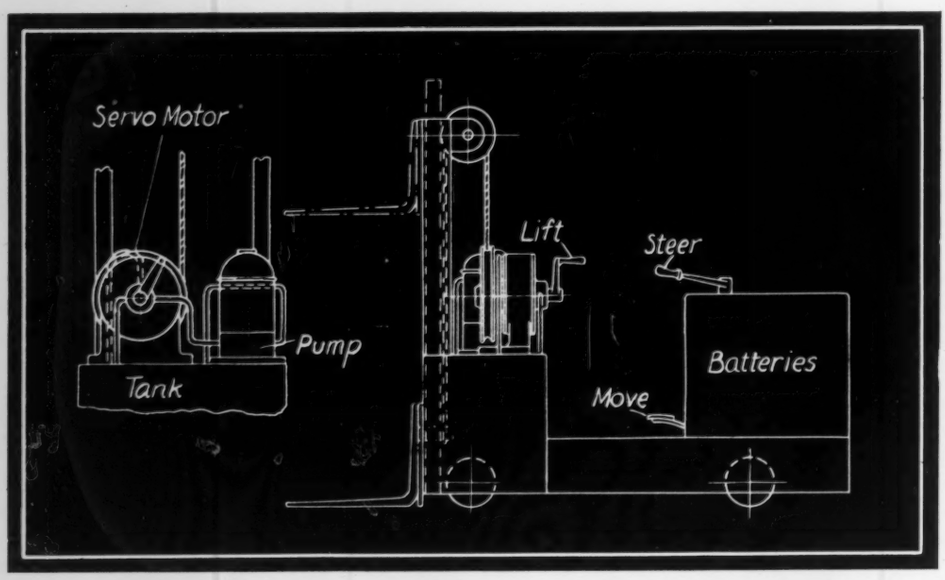


Fig. 2—Application of a hydraulic servo-motor to an electric lift truck

By
Alfred Wasbauer

AS AN adjunct to many machines the servo-motor in its various forms is indispensable where work is too heavy for human hands, repetition too tiresome, or where movements must be repeated with mechanical accuracy. Frequently it leaves its role as accessory and performs by itself.

The electric servo-motor, because of the brilliant development of electric motor controls in the past decade or two, has become especially prominent; but there are still many applications where the nature of the work, the encumbrance of the device, the facilities available and other factors favor the choice of pneumatic or hydraulic types. This article will discuss several uses of the two latter kinds on various types of equipment.

The usual form of a pneumatic or hydraulic servo-motor is a cylinder having a longitudinally displaceable piston and rod for linear motion. When the linear motion required is short, the valve can be cylindrical with a longitudinal motion within the piston. If the linear movement is long, the valve can be a rotating cylindrical shell actuated by the servo-piston through a rack and pinion, cable and sheave, or other means. A servo-motor of this type, used as an air hoist, was described in MACHINE DESIGN, December, 1937, p. 41.

Such a device used as a servo-motor, however, can only transmit rotary motion by translation. *Fig.* 1 shows a servo-motor used as a hoist and adapted to transmit rotary motion directly. An air hoist of this kind is particularly suitable under these conditions: Where compressed air is available, ceiling or overhead obstructions are too low for a vertical cylinder, and fire protection tends to make the use of electric motors undesirable.

This servo-motor hoist consists of a rotor 4 provided with a vane and confined within a cylinder, 7, which also has a vane. Space between the vanes forms airtight chambers, through use of special seals, *b,* flat metal strips cushioned by felt and fitted into suitable slots. Faces of the rotor are likewise sealed by metal rings, 9, cushioned in the same way. This semi-hard felt behind the metal seals combines the properties of spring and packing.

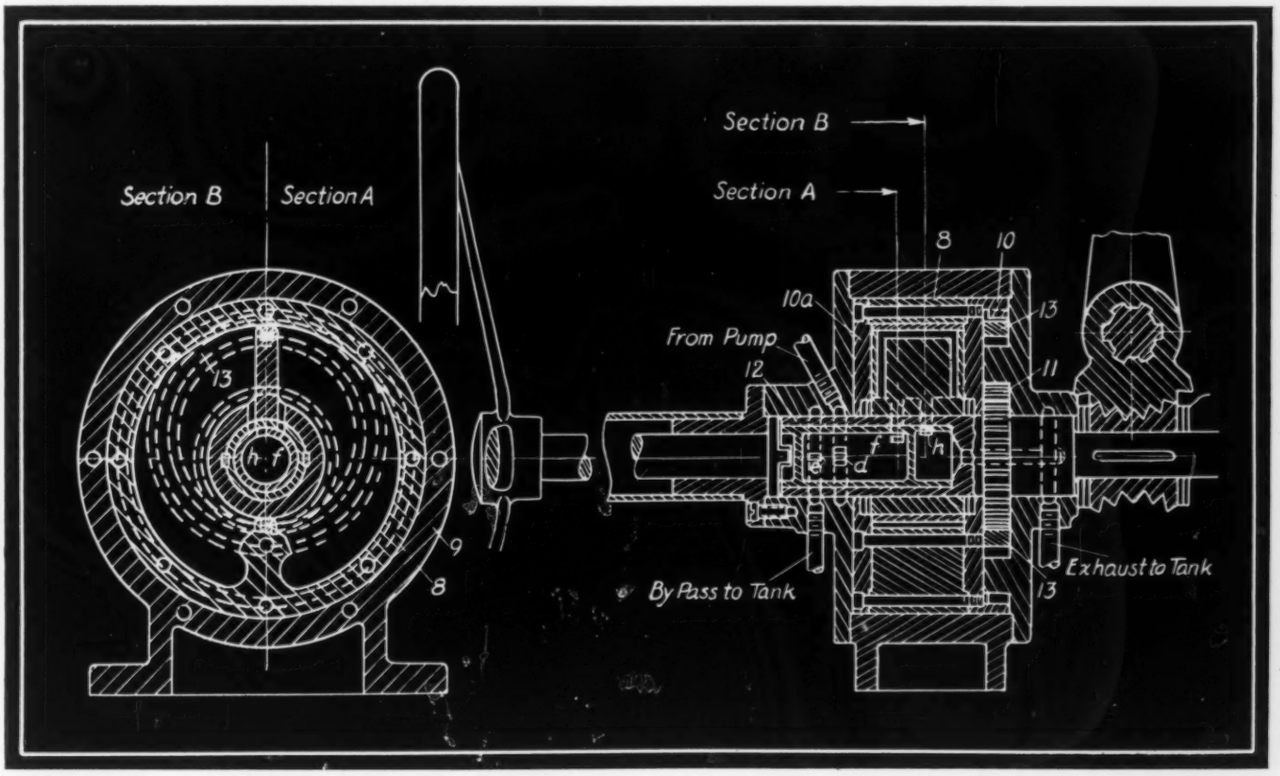
Manual control is obtained through the rack and pinion, 1 and 2, driving the cylindrical valve 3 within the rotor 4. The slot in the valve engaging the tongue of the driver, 6, at *a* is closely fitted, but a similar slot in the end of the rotor 4 is sufficiently wide to permit a slight rotary movement of the valve within the rotor, just enough to open the ports.

Two Pairs of Vanes Can Be Utilized

It can be seen that for an equal reach of lift with a vertical cylinder, the height from trolley to load would need to be nearly three times as great. If less than 150 degrees of rotation are needed either as a hoist or as a servo-motor for any purpose, two pairs of vanes within the cylinder can be used instead of one pair, thus doubling the torque of the rotor.

In *Fig.* 2 is a suggested application of a hydraulic servo-motor to an electric lift truck. Installation is simple. The servo-motor has a valve arrangement, (described more fully in *Fig.* 3), an oil tank and a small motor-driven gear pump, the motor drawing

Fig. 3—Design intended for hydraulic power in which the rotor can make several revolutions in either direction before coming to a dead stop



its current from batteries at the end of the truck.

The design of servo-motor shown in *Fig.* 1 limits the rotor movement to less than one revolution. *Fig.* 3 shows a design intended for hydraulic power in which the rotor can make several revolutions in either direction before coming to a dead stop, thus greatly increasing its range of usefulness. Here the pressure cylinder 8 rotates within a casing 9, which also contains a set of internal gears designed to permit rotor and cylinder to rotate in unison but at different speeds. One flange, 10, of the cylinder is formed as an internal gear meshing with a pinion 11 on the rotor shaft 12 through the intervention of an internal-external ring gear, 13. The rotor will make approximately 2½ turns in either direction from stop to stop, or 1¼ turns either right or left from the position shown in *Fig.* 3. By varying the gear ratios a fairly wide range of turns may be obtained, beginning with one. It should be understood, however, that for cylinders of equal cubic capacity, the torque of the motor shaft will decrease proportionately as the number of turns increases.

By-Pass Lets Pump Run Continuously

The valve in this instance is designed with a by-pass so that the pump may run continuously. In the position shown, the valve is at neutral. The port *d* is always wide open, but the by-pass port, *e*, closes as the intake port *f* and the exhaust port *h*, leading to the cylinder, are opened.

A useful variation of the servo-motor in *Fig.* 3 may be obtained through use of a train of external gears. Greater encumbrance is created, but the cylinder flanges 10 and 10*a* may be eliminated. A greater range of ratios is possible with this layout.

Although the illustration in *Fig.* 3 is a power steering gear for fire engine, truck, tractor or any heavy automotive vehicle, there are innumerable uses for a servo-motor of this type to ease manual labor. By keeping the same steering wheel in this particular case, complete security is obtained. Should the power fail, steering could again be done manually, without a single mechanical adjustment or alteration. Other uses for such a motor can be cited: Operating the cutoff and reverse gear of locomotives, steering large motor boats, opening and closing heavy doors, gates, valves, etc.

Fluid Flywheel Marks Era in Auto Transmissions

(*Concluded from Page* 24)

and be satisfied to ruin it in so doing. Since the fluid flywheel cannot increase the torque any more than could any other clutch, if the engine does not have sufficient torque to propel the car as on a hill, then a lower transmission gear must be engaged. Because there is considerable drag to the fluid flywheel and quick disengagement is impossible but a requisite for gear shifting, the friction clutch must be disengaged by the regular pedal.

Maximum slippage occurs when the car is standing still and the engine idling. The small drag will tend to make the car creep forward but this is overcome by gently pressing on the brake pedal. This is with "high" gear engaged and is a much easier procedure than to put the gears in neutral. Being in "high," one can immediately accelerate by merely releasing the brake and stepping on the acceleration pedal. In stopping on a hill, the car will not roll back if the engine is slightly speeded up above idling so that the drag will balance the rear-roll tendency. All ordinary forward maneuvering can be done in "high." With the overdrive one has almost an automatic two-speed transmission.

The fluid flywheel gives a delightful performance with its "velvety" acceleration and cuts down the effort to drive the car. It is a notable advance in the line of transmission development and the Chrysler contribution is a distinct step in reducing the cost of an otherwise expensive construction.

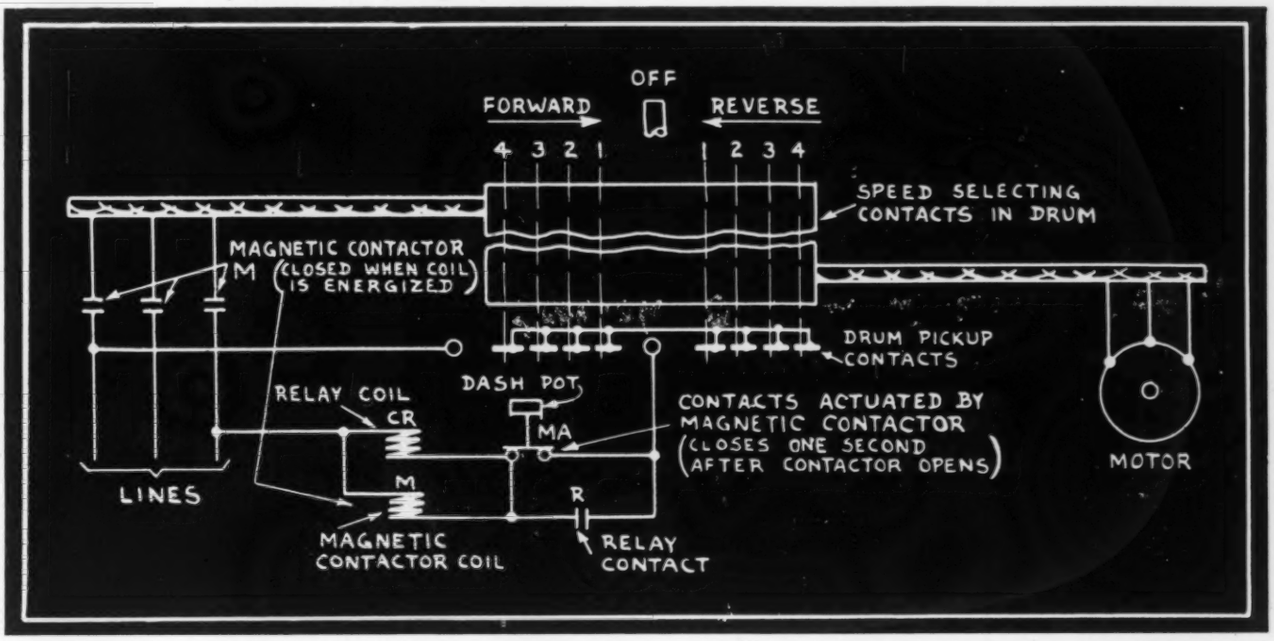
Continuous Hinge Streamlines Tractor with Trailer

SEVERAL engineering features are notable in the design of two Jungle Yacht trailers for use in the Belgian Congo by the tenth Gatti expedition, sponsored by the Belgian government.

Powered with International trucks, the trailers' speed has been increased by streamlining. The space between the trailer and tractor is closed in unusual fashion through use of a pair of articulated flaps attached by a continuous hinge to the rear corners of the tow-car. Rolling freely on the trailer nose by means of swivel casters, the flaps are held against the trailer by means of cables and springs. Closure of the space is attained at all times, regardless of the angle to which the unit might be jack-knifed.

Most of the conveniences of a modern apartment are built into the trailers to insure comfort, including air conditioning units operated automatically or by the push of a button. All outside vents are equipped with air filters. Insulation is provided throughout, the main portion of the trailers being insulated with highly reflective sheet steel. Where low temperatures are required in places where foodstuffs were stored, several inches of loose Kapok are used to insulate.

The entire exteriors of the trailers are covered with steel and steel cemented to plywood, thoroughly sealed against rain and insects. Equipment such as radios, typewriters, etc., is built in to conserve space.



Relay Cuts Maintenance Costs

By R. P. Hunter*

WHEN multispeed squirrel cage motors are used for driving lathes and other machine tools, a drum type controller is frequently employed. This controller is compact, inexpensive and can be operated conveniently by handwheel. A contactor is generally used in connection with these controllers to provide overload and low voltage protection. A pair of magnetic contactors provide means for reversing the motor in addition to protection.

A recent improvement in electrical connections between drum controller and magnetic contactor greatly increases the life of drum contacts, reduces shock to driven parts and gives the operator better control of the machine. These connections are made clear in the accompanying diagram.

Assume that with motor at rest, it is desired to accelerate to fourth (high) speed, using conventional control. When the drum handle is rotated, the motor windings are energized successively at all speeds lower than the "high." It is characteristic of a squirrel cage motor that when the stator winding is energized with motor operating at considerably above or below synchronous speed, current is greatly in excess of normal. When the drum is moved rapidly under such conditions, excessive currents are made and immediately broken, resulting in rapid deterioration of drum contacts.

With the improved control scheme shown in the diagram, motor windings are energized only to afford the desired speed, not on intermediate speeds. Operation is as follows: Contactor M is in series with main motor and drum contacts. Suppose motor is at rest with drum in the "off" position and the operator desires to run his machine at high speed. He immediately rotates drum to the high speed position and it will be evident that he energizes relay coil CR through contact MA as soon as the drum is moved to the low speed position. However, since he is rotating the drum cylinder rapidly, the period of energization of relay coil CR is extremely brief. Although the relay, being quite light, will pick up and close its contacts R, the contactor M will not close during the brief period of closure of relay contacts.

Contactor Stays Open on Intermediate Speeds

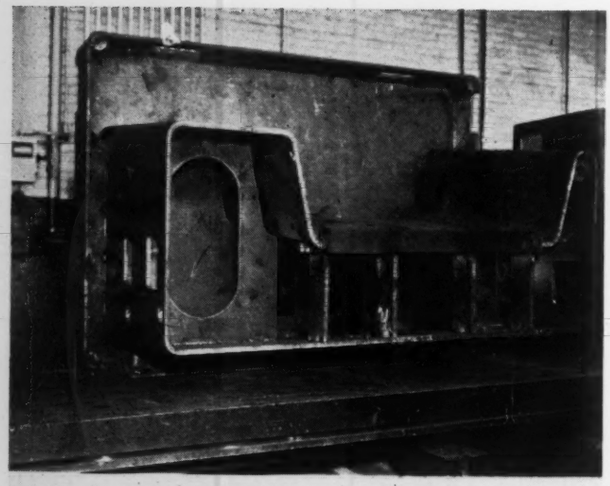
The same sequence of events takes place as the drum cylinder is rotated through second and third speed position. Contactor M does not close, consequently the motor windings are energized. As soon as the

(*Concluded on Page* 48)

* *Supervising Engineer, Cutler-Hammer Inc.*

Weight Is Reduced, Rigidity by Welded Design*

By L. F. Nenninger and W. A. Maddox
Cincinnati Milling Machine and Cincinnati Grinders Inc.



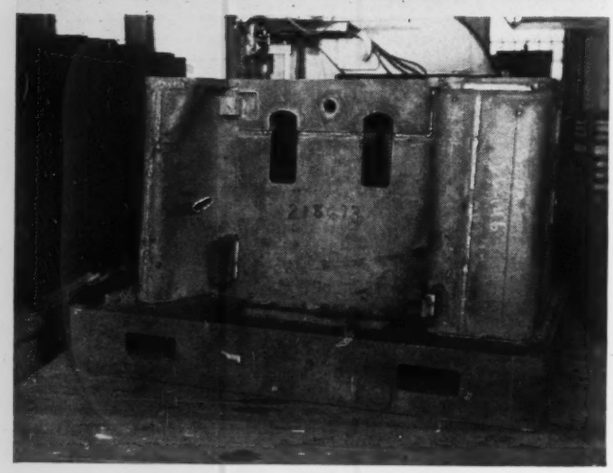


Fig. 1—Top—View looking down into centerless grinder bed, showing internal ribbing. Castings and welded steel are combined. Fig. 2—Above—Front view of completed centerless grinder bed. Smoothness of joints is notable

IN welding a machine tool of steel the designing engineer has the problem of getting all the essential properties into the steel structure that were inherent in the former construction. The direct result of changing to steel is either a reduction in weight or an increase in rigidity, sometimes both. It should be remembered that with steel, the designer does not have to thicken a wall here or modify a corner there or compromise in another place. He knows that if some structural problem does develop in the course of fabrication the cutting torch or arc welding rod will solve it for him. He knows that the strength and ductility of weld metal today is such that he can depend on it not to fail in the welds, assuming his welding practice is correct and that his welders are trained and supervised properly.

Rigidity Can Be Attained with Welding

Rigidity is one phase of the problem of welding about which machine tool builders are sensitive. It has often been said that steel just won't do where rigidity rather than strength is the important consideration. In our experience we have determined that this indictment is unjustified, once welding practice is thoroughly understood. We have discovered that any weaknesses or errors in our first attempts at welding were not caused by the materials we used nor by our theories of construction. Rather, the difficulty lay primarily in where we put our material, how we joined it to the adjacent pieces, what steps we took to relieve stresses after fabrication.

In the case of steel, the stress-strain relationship—the proportionality between the stress and the corresponding deformation or strain even at light stresses—is represented by a straight line up to the true limit of proportionality. Beyond this point a slight increase in stress may produce considerable increase in strain. If we have a welded steel structure, the stresses which are produced in it by welding may be of such intensity as to subject the structure to deformations progressing beyond the limit of proportionality. Therefore, the structure will be distorted until equilibrium is reached between the stress and the cor-

** From a paper presented at the annual meeting of the American Welding Society.*

Increased

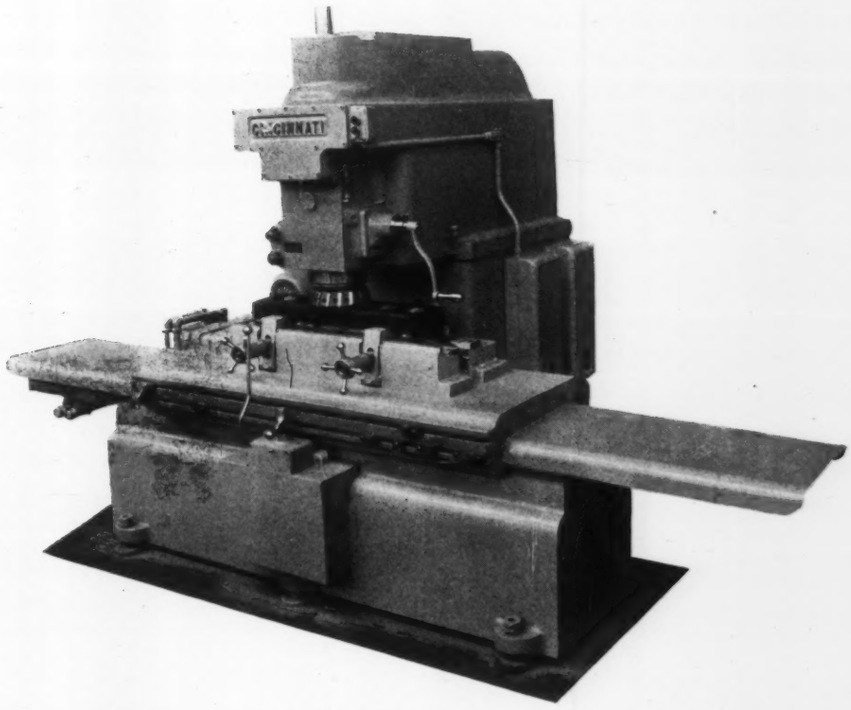


Fig. 3—Completed light weight Hydromatic milling machine, bottom view of which is shown in Fig. 8. Spacer, bed, and table are steel

responding strain. The additional load, corresponding to the residual stress, will cause a still greater permanent deformation.

In order to avoid this condition it is desirable to reduce the internal stresses to a point far below the proportional limit. The stress thus obtained, which can be called a residual stress, when added to external stress produced by a load under use, should not exceed the proportional limit, otherwise, high loads when applied will produce a stress sufficient to cause a plastic flow and a permanent deformation. If, however, by some type of stress-relieving process the residual stress can be reduced to some value in the vicinity of 3000 pounds per square inch or less, a stable structure will be produced.

In the matter of thermal stress-relief there is much experimental evidence available to show that if we heat a welded steel structure through the correct heating and cooling cycle, holding it at approximately 1200 degrees for a reasonable length of time (usually one hour per inch of thickness), the residual stress will be below 3000 pounds per square inch. As mentioned above, this value is so definitely below the proportional limit for steel that a stable structure is assured.

This fundamental fact in the plastic flow of steel is important. Unlike other metals, steel after proper stress relief will be permanent unless forced past the proportional limit.

Cast Iron Properties Desirable

Though this paper primarily covers developments in machine tools from the standpoint of welding, it would not be well to forget the wonderful properties of cast iron. Cast iron is an almost ideal material for the machine tool builder's purpose from many points of view. Its strength is more than sufficient for most requirements encountered in design. It has a deadening power and an amazing ability to absorb vibration that no other suitable metal possesses. It has natural internal properties that enable it to dampen vibration set up by the various machining processes. It can be planed or milled to form a "way" or guide surface which is suitable for almost all applications. Early welded structures used bolted on cast-iron ways and such ways are still being used in some applications. The rigid and hard requirements imposed on production machine tools in high production shops in a number of cases, however, has led to the use of hardened way surfaces. Whether this is justified for ordinary usage is a matter much discussed and one that is now being carefully considered.

Styles Should Fit Use of Metal

It is felt that the proper way to approach the appearance of welded steel structures is to establish styles that fit into the proper use of the metal. Early efforts in the use of steel were along the lines of copying other structures or of going to extremes in box construction. We now recognize that just because a method of design or style was good when applied to other metals, it does not follow that steel is applicable in a like manner. Times are changing; new shapes, lines, appearances, styles are with us. With as versatile a method of manufacture as welding available we certainly cannot be content to build steel machines with exterior lines that looked up-to-date

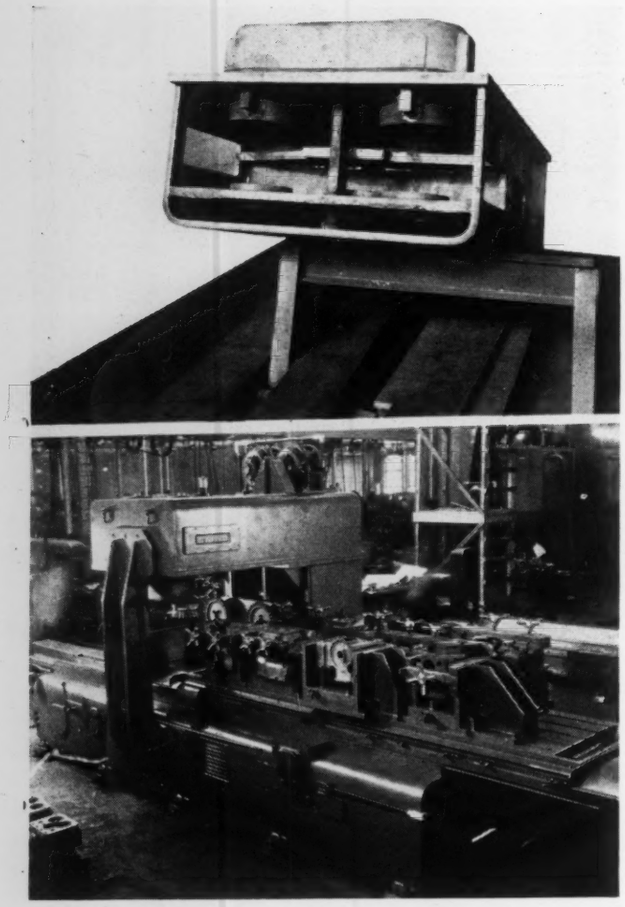


Fig. 4—Top—Looking into the end of a fixed height rail having built-in spindle carrier. This section is used in the machine in Fig. 5. Fig. 5—Above—Front view of special steel milling machine with four spindles for milling seven surfaces of two-cylinder engine block

yesterday. *Fig.* 1 is a good example of the possibilities of making appearance conform to the proper utilization of fabricated steel structures. This machine combines castings and welded steel to make a special purpose machine which, while not conventional, certainly is not displeasing to the eye. Its massive suggestion of power, of rigidity, is so definite that it gives one faith in the finished machine tool.

A full realization of the inherent possibilities of welded steel fabrication came to our company after we developed the No. 6 centerless grinder, interior of which is shown in *Fig.* 1. Formerly the machine was built in two pieces and weighed over 9600 pounds; welded of steel, it is in one piece, weighs 6600 pounds. Performance of this machine is excellent and there has never been any problem of chatter, vibration or any of the kindred ills sometimes attributed to welded steel machine tools. The machine is built up through careful placing of metal exactly where it is needed. Pleasing lines are obtained by cold bending.

Vibration Presents Knotty Problem

Because vibration is especially serious and the average milling cut tends to set up chatter, a knotty problem arises in connection with welded steel milling machines. This problem becomes worse when intermittent cuts are to be made using one or more large inserted blade mills.

Figs. 4 and 5 show a special Hydromatic milling machine with four spindles for milling the seven surfaces of a small two-cylinder engine block. Of particular interst is *Fig.* 4 because it shows intricate bracing used for additional rigidity. A number of shafts and large gears go into the compartment illustrated. *Fig.* 5 is a view of the complete machine.

In order to know just how rigid such a welded

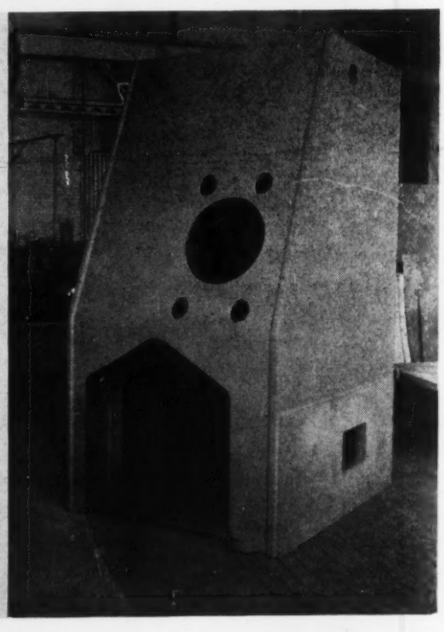


Fig. 6—Extreme left—Upside down view of Hydro-Tel milling machine base, in one piece. Fig. 7—Left—Machine headstock, showing finished painted structure prior to machining

machine tool can be, three very accurate reading dial indicators were placed on the outer corner of the fixed height rail carrying the vertical spindle carriers. The deflection readings were extremely low, definitely less than skeptics had expected. A careful analysis of the source of the small deflection we did find, moreover, taught us some things which will enable us to produce a similar machine lighter in weight and yet more rigid. In *Figs.* 3 and 8 are shown views of our light weight hydromatic milling machine of welded steel. Bracing and ribbing can be clearly seen in the base, *Fig.* 8.

An interesting, but difficult, job is milled by the large welded horizontal Hydro-Tel machine in *Figs.* 6, 7, and 9. Present time for milling this piece is 8 hours, with 45 minutes for hand dressing time. The time formerly was 48 hours on a good milling machine, with 8 hours hand dressing time.

The bed of this machine is in one piece, eliminating the making of a bolted joint, yet its weight is moderate. Internal ribs are distributed according to the rigidity requirements at that particular section. Beds from 10 to 25 feet long may be built using the same equipment and design.

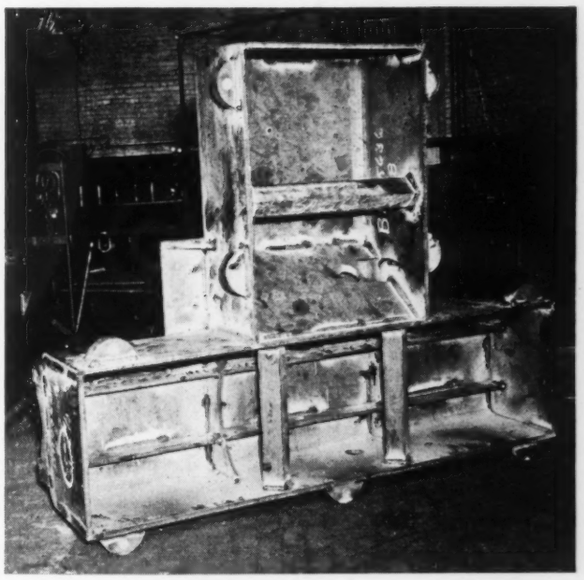
Broaching machines, single ram, double ram and large horizontal types, have set a new pace for production and accurate machining of plain and curved external surfaces. Welding is utilized from beginning to end in their construction.

One of the most nearly ideal welded machine tool beds it is possible to build consists of two standard angles and a standard I-beam. A few ribs of ¾-inch plate are welded into the bottom and 14 supporting feet are welded on. The amount of labor per pound of material is abnormally low, yet the rigidity is everywhere it is needed and in the correct plane. Advantages of this design are numerous: Stock material is used, cutting waste is very small, component parts fit together without effort.

Rigidity Maintained Over 33 Feet

Such a bed, for a giant cylinder block broach, is 33 feet, 10 inches long, weighs 26,000 pounds. Rigidity must be maintained over this length. A complete cast iron bed of sufficient rigidity would weigh between 39,900 and 45,000 pounds. These machines do contain iron castings, however, as well as sheet steel, steel plate, steel castings, forgings and heat-treated alloy parts, each form of metal being applied where it is best suited to do the work required. Material chosen is dictated by its mechanical properties and its relative merits for the work and service it is called upon to perform.

The broach work fixture for handling and holding the block demands strength as well as rigidity, yet it must have some big openings, at embarrassing places, for the cylinder blocks, piping, dust removal, and operating details. In working out the operations



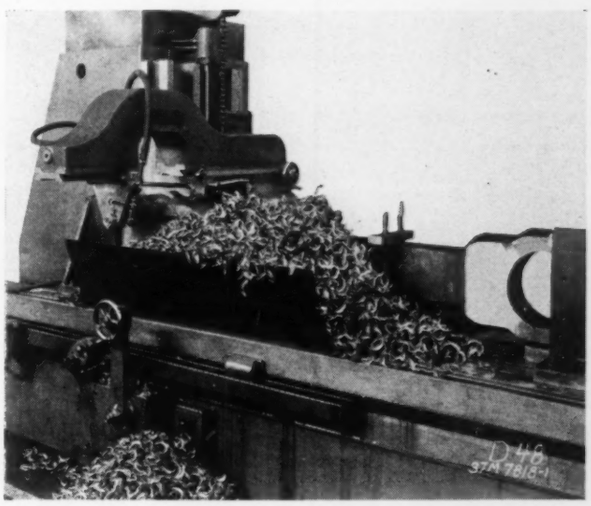
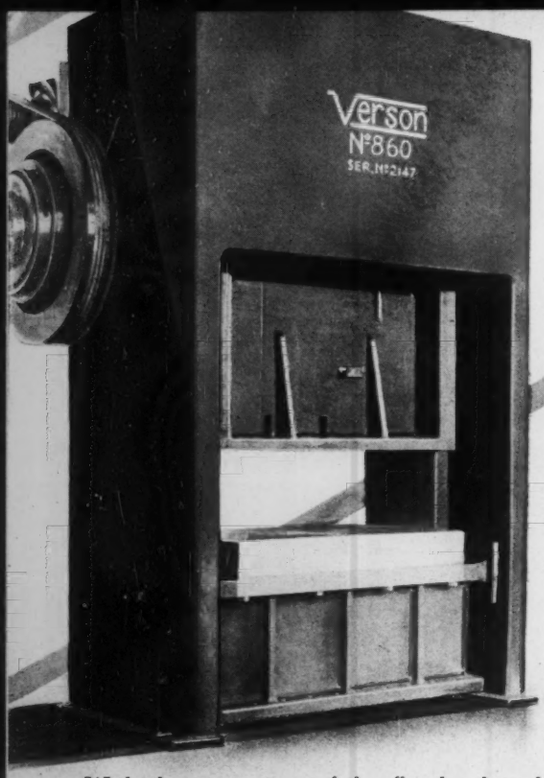


Fig. 8—Above—Bottom view of light weight welded steel milling machine bed after welding. Bracing and ribbing can be seen clearly. Fig. 9—Below—Hydro-Tel milling machine, consisting of welded bed, column and special steel rectangular overarm, making a type of cut prone to set up unusual vibration

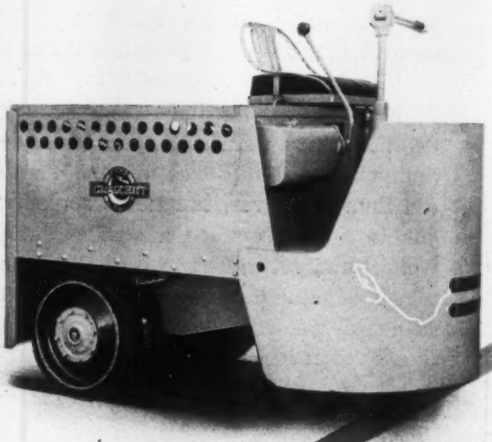
using steel, it is possible to make or enlarge openings or to close up holes or move lugs and bosses. Welded steel fabrication, in other words, offers a freedom in design and manufacture.

Given the proper machinery and tools the welding shop will produce machine tool structures at a reasonable cost. Further, with a steel structure we have the flexibility of being able to make preliminary tests and minor changes to meet new or unanticipated changes in the part being machined or in the machine tool structure itself. Plates, ribs, braces, passages, details of all kinds may be added when needed. This flexibility is particularly valuable on jobs where there is no time for models or extensive preparatory developments.



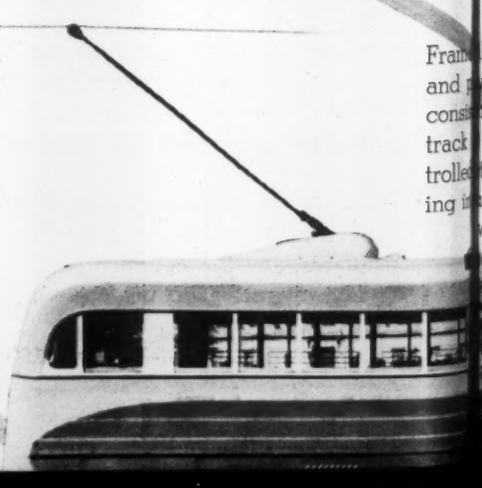
With the exception of the flywheel and clutch, operating parts of the Verson full eccentric press, above, are enclosed in the crown. Conventional crankshaft is replaced by a pair of shafts stationary front to back, on which eccentrics revolve. The eccentrics are integral with two bull gears connected to the press slide by steel pitmans or eccentric straps

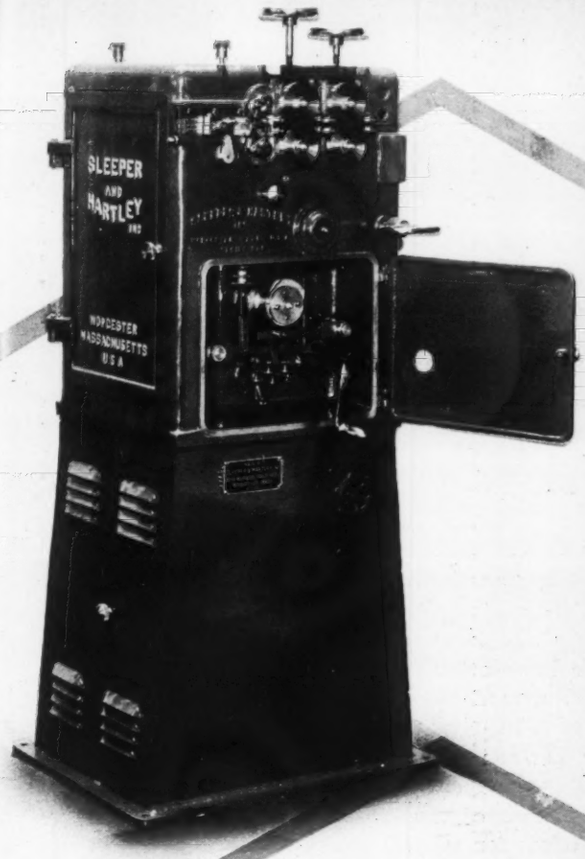
Duplex silent chain and worm drive, totally enclosed in a cast steel housing, is used in the Crescent three-wheel tractor, right, for distribution of materials at terminals. Oversize external contracting brake is mounted on worm shaft, and no braking torque is transmitted through motor. Driving unit is supported on chromium vanadium semi-elliptic springs, fitted with alloy steel pins and bronze bushings. Formed and welded structural shapes and plates make up the frame



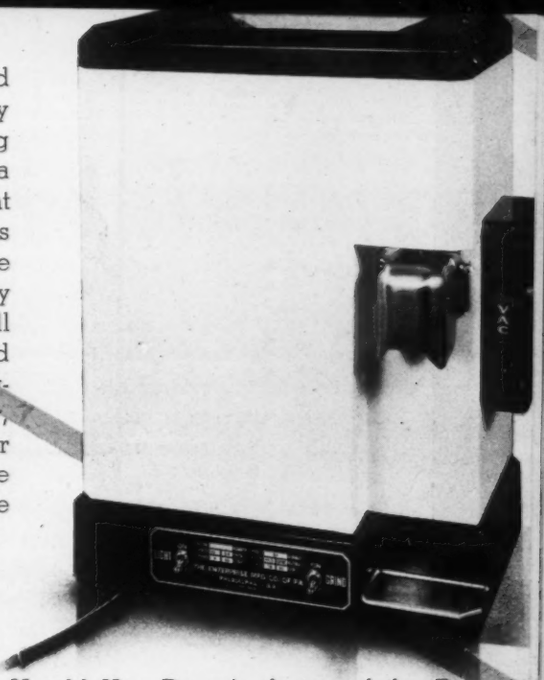
Styled in keeping with modern trends, the Ozalid high speed automatic white print machine, right, combines printing and developing apparatus under one sleek housing. Variable speed operation is provided, and the machine will produce prints up to 42 inches wide at speeds as high as 20 linear feet per minute. Uniform exposure essential to perfect printing is assured by use of a single, special high-pressure mercury vapor tube. Air entering the cylinder for cooling the tube is filtered

The General Electric television receiver, left, employs a cathode-ray picture tube 12 inches in diameter and includes pushbutton station selectors for "tuning" any one of the seven authorized channels for broadcasting. The picture is viewed in a mirror on the under surface of the lid, which is raised at an angle when viewing. These receivers are to be placed in test operation in certain areas to obtain information on performance in actual service





Cam control of the pitch and diameter on Sleeper & Hartley universal segment type spring coiler, left, is centered in a recessed cabinet on the front side, obviating laborious reaching inside. One-piece cast iron housing gives rigidity and perfect alignment. Ball bearing construction is used throughout. Crank is removable, for set-up purposes only, during operation. Motor or pulley drive and variable speed transmission is available

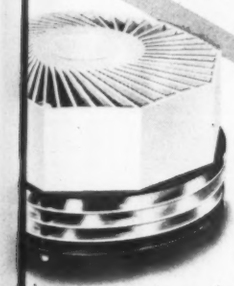


Harold Van Doren's design of the Enterpri coffee merchant, above, has the sales anc prominently in mind. Body is pressed steel w white porcelain and black trim finish. Upp rim is die cast zinc. The brush-lifting ty motor is rated at ¼-horsepower. Compa the mill meets the need for counter machin which do not obstruct view of shelves. carries a sales message on the reverse si

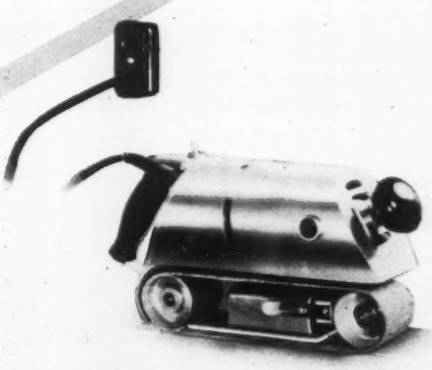
Design Features In New Machines

A Pictorial Presentation of Recent Machinery from the Standpoint of Design

(For new machine listing see page 82)



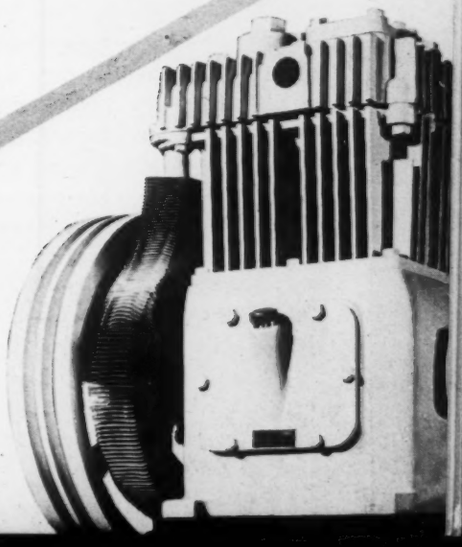
ake apertures of the r circulator, above, are e steel stamped rings, d, and two black rings. The whole is nc or plastic housing



When the Quincy air compressor, below, is be used for automatic start and stop contr it comes equipped with a loadless starti device which automatically withholds all lc from motor until it reaches full speed. Cylind with integral cooling fins are cast in one blc of special nickel alloy iron. Two-bearing sha are used with roller main bearings to t radial and thrust loads

lliner, below, is rolled steel sections elded and riveted. Brake equipment bination of dynamic braking, magnetic and wheel tread air brakes, all con- operation. Rubber is used for spring- cks. Safety sheet glass is in all doors windows except the windshield

The GuildSander, above, is built with a die-cast aluminum frame, finished in baked aluminum enamel. Endless abrasive belts, traveling 600 feet per minute, may be changed instantly by means of a new catch- and release spring plate. The 110-volt universal motor plugs into any light socket, alternating or direct current. Weight of the tool is only nine pounds



Consideration of Machine Operator Again Comes to Fore

DIRECTORS of a considerable number of the largest business organizations in the country have laid emphasis on the status of the workman in recent addresses. On every hand one sees and hears evidence that industrial leaders view the maintenance of eminently satisfactory relations between management and labor as one of the major factors in business recovery.

Chief engineers and designers of machinery can do little—directly—in solving this problem. They have it within their power, however, to make more pleasant the working conditions of the operators of machines. Alert engineers have kept this in mind with increasing effect for several years, but the time has now come when efforts to improve safety, convenience and ease of operation should be redoubled.

A machine that is apt to tax a man's strength to the limit, jar his nerves to breaking point or keep him in continuous fear from a safety standpoint never should be allowed to reach the stage of development. Machine operators recognize, for their part, that we cannot expect Utopia, but at the same time they take great pride and satisfaction from the handling of a machine that involves consideration of the operator as a primary factor. Additional emphasis on this phase of design cannot be overstressed under current conditions.

Happy New Year!

PLANS and resolutions for 1939 and the future, as well as a brief glimpse into the past, are in order as this is written. Old friends and readers may recall that MACHINE DESIGN embarks with the current issue on its tenth anniversary year. Published first in September, 1929, the magazine has not by any means swept to success on a wave of prosperity! It has had a hard road to travel during the ten years as far as general business conditions are concerned, but that it has become firmly established during that time as "The Professional Journal of Chief Engineers and Designers" can amply be testified by the innumerable favorable comments continuously reaching its publication offices from readers in all parts of the country.

Plans for the future include a change in editorial staff effective with this issue. Guy Hubbard, associate editor for several years, has transferred to *Steel,* with which this journal is affiliated. Replacing him in the same capacity on MACHINE DESIGN is John W. Greve, formerly of Westinghouse Electric & Manufacturing Co. and a well-known figure in the field of technical publications.

MACHINE DESIGN would like to take this opportunity of wishing every reader a Healthy, Happy and Prosperous New Year!

ASSETS *to a* BOOKCASE

Engineering Mechanics—Two Volumes

By S. Timoshenko and D. H. Young; published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for* $2.75 *per volume, postpaid.*

Aim of this textbook is to give the young engineer a familiarity with fundamental principles of mechanics and to illustrate the application of many methods of attacking problems which ordinarily would not yield readily to routine methods of solution.

DYNAMICS—In the book on dynamics, the authors emphasize that this is a subject not to be handled superficially. Throughout the book, equations of motion are presented as differential equations. Almost all of the illustrative examples are presented in algebraic form, the answers being given simply as formulas. This has the advantage of making possible several checks and is much more flexible in application. Contents of this 323-page book are divided into eight divisions—kinematics of a particle, principles of dynamics, rectilinear translation, curvilinear translation, rotation of a rigid body about a fixed axis, plane motion of rigid bodies, and relative motion.

STATICS—In this work no special chapter is reserved for the subject of friction, this being handled in various discussions throughout the book. Theory of statically determinate stresses and space frames is discussed in a rather complete manner. Since this subject is given in many schools before integral calculus, this volume assumes a knowledge of differential calculus only. Free use of mathematics is made within these limits, however. In eight chapters, the principles of statics, concurrent forces in a plane, parallel forces in a plane, and other cases are covered in detail.

□ □ □

General Discussion on Lubrication

Published by American Society of Mechanical Engineers, New York; available through MACHINE DESIGN *for* $12.00, *postpaid.*

This book is a collection of 46 papers on journal and thrust bearings and 33 papers on engine lubrication, contained in 648 pages in the first section, in addition to 25 papers on industrial applications and 32 papers on properties and testing of lubricants in the second section containing 507 more pages. These were presented at The British Institution of Mechanical Engineers' October, 1937, meeting, London. All in all, it is a most comprehensive treatment of the subject of lubrication and lubricants, compiled with the customary thoroughness of the British.

As might be expected, practically every angle of the subject is covered in one or more of these papers, including such related subjects as effect of seizure, influence of pressure on film viscosity, instability of oil films, temperature rise in bearings, prevention and control of oil fires. Designers will find much of interest in this collection of excellent papers as all types of the newer bearing materials are treated including the synthetics, bearings designs of infinite variety and full discussion of the many factors entering into the correct design and application of bearings.

□ □ □

Elements of Mechanism

By Peter Schwamb, Allyne L. Merrill and Walter H. James; published by John Wiley & Sons Inc., New York; available through MACHINE DESIGN *for* $3.50, *postpaid.*

Here is a 400-page book in its fifth revised edition widely accepted as a text in the study of mechanisms. Originally prepared by Professor Peter Schwamb for use at Massachusetts Institute of Technology, succeeding revisions have placed added emphasis on certain parts of the subject. In this last edition, important changes include a more thorough discussion of the general laws of motion with special attention to acceleration, replacement of some of the old examples by others based on present-day practice, rearrangement of certain chapters, and placing of problems which apply directly to a chapter at the end of that chapter.

Frequent use is made of the simpler methods of calculus in the mathematical treatment but most of these sections may be omitted without destroying the continuity of the work, if it is desired.

□ □ □

Kent's Mechanical Engineers' Handbook—Design and Shop Practice

Published by John Wiley & Sons Inc., New York; availabe through MACHINE DESIGN *for* $5.00, *postpaid.*

The eleventh edition of a well-known authoritative treatise, this book has been completely rewritten by R. T. Kent to fit into the recommendations of the publishers advisory board. Following these recommendations, fundamental material underlying all engineering is to be published in a separate volume and existing handbooks revised to contain material closely related to the specialized branches of engineering. The Wiley Engineering Handbook Series, just initiated, will contain: Eshbach's "Handbook of Engineering

Fundamentals"; Kent's "Mechanical Engineers' Handbook" in two volumes—"Power" and "Design and Shop Practice"; Pender's "Electrical Engineers' Handbook" in two volumes—"Electric Power" and "Communication and Electronics."

The present book, fitting into this series as one of the two volumes for the mechanical engineer, is particularly of interest to designers as it contains a wealth of information on the new design materials, improvements in machines, tools and process which make previous editions obsolete. General properties of material, iron and steel, corrosion resisting metals, nonferrous metals and alloys, nonmetallic materials, as well as fabricated materials are covered in addition to subjects such as fastenings, mechanisms, rotating members, control devices, etc. Separate sections also cover approved practice in foundries, forge shops, machine shops and woodworking plants.

□ □ □

The Practice of Lubrication

By T. C. Thomsen; published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for* $6.00, *postpaid.*

Developments in lubrication since the second edition of this work was published in 1926 have made this third edition imperative for inclusion of the many alterations and additions necessary. Today users have available a greater variety of crudes, lubricating oils with noncarbonizing and nonemulsifying properties due largely to improved refining methods.

Of particular interest to the designer is the effect newer lubricants have upon bearing design and application. In the mechanical field, the author points to the "Nomy" bearing principle as an important development which appears to open up great possibilities for longer life and exceedingly low frictional losses for all types of bearings.

Attention also is directed to the ever-widening use of circulation oiling systems for high-speed engines and machinery and how this has brought about an increased number of centrifugal oil purifiers and, in certain fields, "streamline" oil filters. This 639-page book is essentially an engineering treatise on the origin, nature and testing of lubricants, their selection, application and use. It appears to cover this field most thoroughly.

□ □ □

Handbook of Refrigerating Engineering

By W. R. Woolrich; published by D. Van Nostrand Co. Inc., New York; available through MACHINE DESIGN *for* $4.00, *postpaid.*

This, the second edition, is a comprehensive work covering the many phases of refrigeration methods, mediums, equipment and applications. Due to the large number of advances in this field, especially in connection with the quick freezing of foods, the revision of the first edition contains much new information, in fact, a complete chapter is devoted to the quick freezing of foodstuffs. The book is complete with a large number of tables, charts, a 12-page index and illustrative diagrams. There is a section on thermodynamic equations, constants and mathematical treatment of refrigeration elements.

Both the absorption method and the absorption machine receive a detailed discussion in separate sections of the book. In addition to much design data, valuable information is included covering practical problems such as how to test various refrigeration systems. Individual sections also are devoted to refrigerants, condensers, electric refrigerators, ice and ice making, air cooling and air conditioning, storage of meat, heat transfer and insulation, as well as separate sections on the more prominent refrigerants including ammonia, carbon dioxide, sulphur dioxide, freon, and methyl chloride.

Relay Cuts Maintenance Costs

(*Concluded from Page* 39)

drum reaches the fourth or high speed position and remains there, contactor M closes, thus causing motor to run at high speed. Contact MA is opened by closure of contactor M.

When the operator desires to reduce machine speed or shut down altogether, he moves the drum in the opposite direction thus de-energizing relay coil CR. This relay, being very light, opens within a fraction of a second and de-energizes coil M, thus opening contactor and relieving the drum of all arcing. Contact MA is delayed in closing (by dashpot or other suitable means) for a comparatively short period (one second or less). Consequently relay coil CR is not again energized until the operator allows the drum to remain in the desired reduced-speed position for at least one second, thus causing contactor M to close again.

It is evident that contactor M will not close until the operator moves the drum to a desired speed position and leaves it there for a brief period (or for as long a period as may be desired). Also it is evident the contactor does not open and close during intermediate drum positions, and that motor windings are not energized at any speed except the speed desired by the operator. This insures that the motor is not energized and de-energized at intermediate speeds, which greatly reduces mechanical strain on the motor and machine parts, and practically eliminates arcing in the drum. Furthermore, control of the machine is effected entirely by movement of the drum controller handwheel, no pushbutton being required to close the contactor.

Men of Machines

BEING appointed as chief engineer of a newly-consolidated and enlarged engineering department of Thew Shovel Co., Lorain, O., is an honor well earned by R. H. Zeilman, formerly assistant chief engineer of the company.

A graduate of Carnegie Institute of Technology in 1916, Mr. Zeilman served in the Air Service during the World war. Until 1922 he held drafting and engineering positions with the Chicago Pneumatic Tool Co., Doner Steel Co. and the Power Specialty Co., at which time he entered the employ of the Thew Shovel Co. as a member of the engineering department. Two years later, in a reorganization, he was placed in charge of the drafting room at the Lorain plant of the company. His next appointment was that of assistant chief engineer, and now, chief engineer.

R. H. ZEILMAN

• • •

RECENT transfer of George E. Burks from the California plant of Caterpillar Tractor Co. to Peoria, Ill., and his appointment as assistant chief engineer, bring recognition to his experience and qualifications in engineering. He began his early training as a draftsman doing detail work with Western Harvester Co., Stockton, Calif., and was later placed in the company's field engineering and research branch. Here he remained until his transfer to the San Leandro plant of Caterpillar Tractor Co. when this company acquired the Western Harvester Co. Progressing rapidly through tractor and engine layout work and the position of chief draftsman, he was placed under the chief engineer and vice president in charge of the research division. Later he was in charge of research engineering, the position he held at the time of his appointment.

GEORGE E. BURKS

• • •

LEWIS B. SWIFT, who since 1934 has been vice president in charge of engineering research and design of Taylor Instrument Companies, succeeds Herbert J. Winn, retiring president, in the presidency of the company. Mr. Swift first joined the Taylor company immediately upon graduation from high school in 1904. Four years later he entered Cornell university, but continued working for the company during vacation periods. Receiving his mechanical engineering degree in 1912 he rejoined the company on a full time basis as a member of the industrial sales division. In 1919 he organized and took charge of the sales engineering department.

Within the next ten years he made rapid advancement and was elected a director of the company. He became chief engineer in 1929 and remained

LEWIS B. SWIFT

in this position until 1934 when he was made vice president in charge of engineering research and design.

♦

KARL H. HUBBARD has been appointed chief engineer, in charge of engineering research and design of Taylor Instrument Companies, Rochester, N. Y. DR. H. L. MASON succeeds Mr. Hubbard as head of the research division of the company.

♦

THOMAS R. JONES, president of American Type Founders Co., has been elected president of the National Printing Equipment association. R. V. MITCHELL, president of Harris Seybold Potter Co. was elected vice president.

♦

WALTER A. PARRISH has resigned as chief engineer in charge of design and development of gasoline and diesel engines for automotive, industrial and marine application, of the Buda Co., Harvey, Ill.

♦

R. E. ZIMMERMAN has been elected vice president of the American Standards association, New York. Mr. Zimmerman is vice president of the United States Steel Corp., Pittsburgh.

♦

EARL P. ORDWAY, vice president and chief engineer, has been elected president of the Union Steam Pump Co., Battle Creek, Mich. Mr. Ordway, who succeeds C. W. BRAINERD, recently resigned, has been with the company for 31 years.

♦

EARLE C. DERBY, president and treasurer of Buckeye Stamping Co., Columbus, O., has been elected president of Battelle Memorial Institute, Columbus.

♦

L. A. SCHMIDTT has been appointed vice president of National Tool Co. He was formerly chief engineer.

♦

J. R. TOWNSEND, materials standards engineer of Bell Telephone Laboratories Inc., New York, has been made a member of the executive committee of American Society for Testing Materials. He succeeds Allen Rogers, recently resigned.

♦

E. T. LORIG has been named chief engineer, Irvin works, Clairton, Pa., of Carnegie-Illinois Steel Corp. R. J. MACKENZIE has been made assistant chief engineer, and KLAUS EGGE, chief design engineer.

♦

J. CARLTON WARD JR. has been appointed vice president and a director, United Aircraft Corp., New York, and general manager, Pratt & Whitney Aircraft division of the company, East Hartford, Conn.

♦

WILLIAM A. KIMSEY, formerly chief engineer of the LeBlond Aircraft Engine Corp., has been appointed chief engineer for Ken-Royce Aircraft Engine Co., Kansas City, Mo., newly-organized.

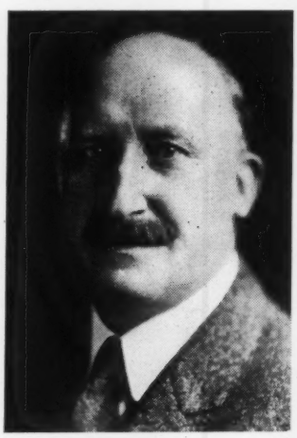
♦

JAMES H. GAMBERTON has been added to the technical staff of Acheson Industries Inc., New York, and will supervise engineering tests involving new applications of the products of the company's affiliate Acheson Colloids Corp.

♦

CARL L. PEIRCE JR. has been elected president of the National Electrical Manufacturers association. Mr. Peirce is president and director of Hubbard & Co. and some of its subsidiaries.

Obituaries



PERCY C. DAY, vice president and chief engineer of Falk Corp., died December 7, at the age of 63. He was a prominent engineer in the development of gearing, marine and rolling mill equipment. Coming from England in 1910, he immediately joined the Falk Corp., and twenty years later was named vice president of the company. Mr. Day performed pioneer work in the electric-metallurgical field, principally in developing electric furnaces and calcium carbide, before becoming associated with the gear industry where he directed work in helical and herringbone gearing. He was recognized throughout the world as a leading authority on design of helical gears.

Mr. Day was an inventor and held a number of patents relating to gear type equipment, gear transmission and large drives for roller mills.

♦

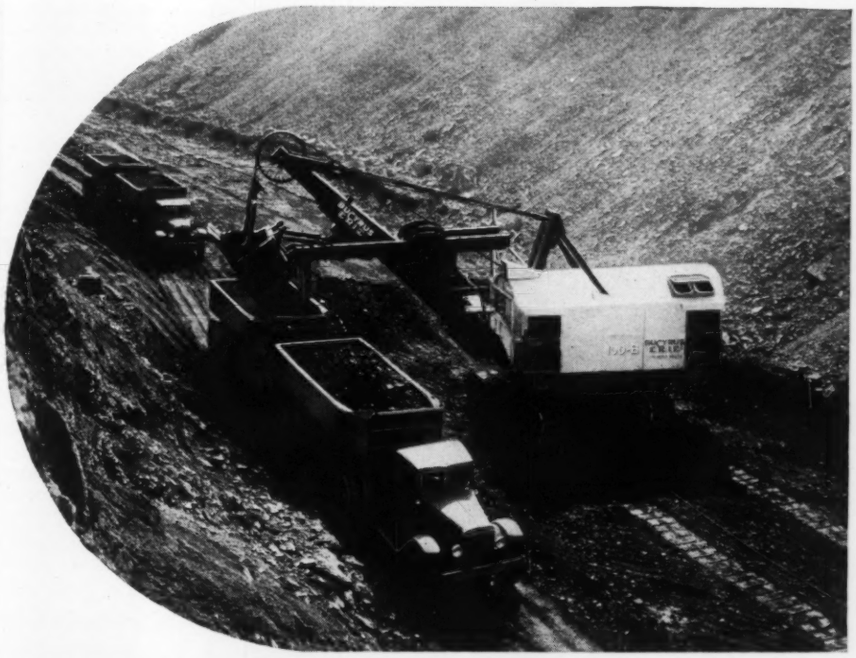
FRANK D. CARRICO, 65, an automotive designer for thirty years, died recently in Detroit. As chief engineer of Willys-Overland Co. he designed the early Overland car, and later designed and developed the Carrico aircooled engine. He also helped to design the Franklin aircooled engine. At the time of his death he had been a special machine designer for the National Broach Co. for four years.

♦

HORACE B. SPACKMAN, retired vice president of Lukens Steel Co., died December 11 in his seventy-seventh year. Mr. Spackman was also president of Lukenweld Inc., until 1936.

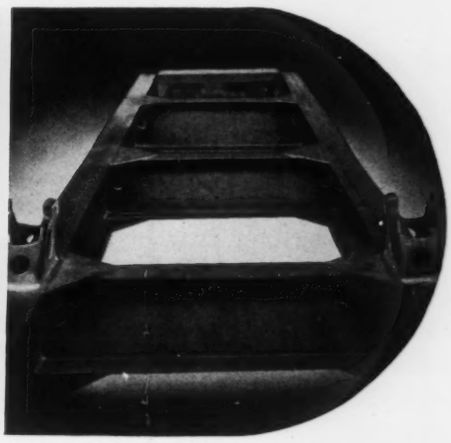
NICKEL ALLOY STEELS

Boost the PAYLOAD . . . and CUT HAULAGE COSTS



40 TONS PER TRIP

Typical of the tremendous capacities that are being developed through the use of the Nickel alloy steels, are these trailer units which handle 40 tons of coal per trip in an Illinois strip mine. By employing strong, tough Nickel alloy steels, the manufacturer, Austin-Western Road Machinery Co. of Aurora, Ill., was able to develop giant trailers which have substantially reduced haulage costs. Weight of parts was materially reduced, without decreasing safety factor or dependability. Nickel alloy steels were used for the rear axles, spring shackle bolts, spring shackle shaft, spring clips, wheel studs, brake drum bolts, air cylinder valve stem, cross head and pivots.



WEIGHT REDUCED 25%–30%

Another striking example of high pay load capacities which the Nickel alloy steels make possible is this semi-trailer which carries a 20-ton load concentrated over a length of only 8 feet. The high strength-weight ratio of the Nickel alloy steels effected a saving of 25-30% in the weight of the frame as well as substantial weight savings in other highly stressed applications. Producer of this unit is Utility Trailer Manufacturing Co. of Los Angeles, using Nickel alloy steels obtained from Bethlehem Steel Co.

We invite consultation on the use of the Nickel alloy steels in your equipment.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

NOTEWORTHY PATENTS

THE torque converter (Torkonvertor) whose vertical transverse section, partly broken away, is shown in *Fig.* 1, is a multiple speed transmission for internal combustion motors or any other prime mover characterized by low starting torque. The diagram shows the accelerating chains in initial or wound position, and in high speed or unwound position.

Main feature of the motion involved in this transmission is shown in the illustration. On the ends of two shafts are driving elements rotatable in only

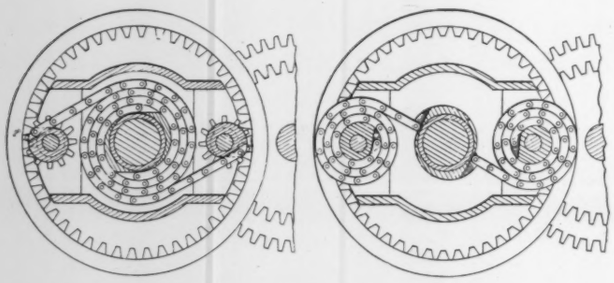


Fig. 1.—*Wound and unwound positions of torque converter for prime movers with low starting torque*

one direction through an overrunning clutch. Also freely rotatable relatively to the shafts in the same directions are gear carriers, upon which are mounted gears that turn bodily therewith. Through a main clutch, the driving elements lock for rotation with otherwise loose pinions on the shafts. Through the gearing on the gear carrier and gears fixed to the shafts, the latter are started slowly to a uniform speed of the driving elements. The gearing is of such a nature that it accelerates this speed until it completes a cycle and then locks all parts together for a direct drive or a speed of rotation the same as that of the driving element. When the main clutch is disengaged or thrown out, the continuous movement of the driving elements or its movement, if stopped, resets the differential gearing for a succeeding cycle.

Elevators Brought to Full Stop

OBJECT of the invention shown diagrammatically in *Fig.* 2, is to provide an effective, electrically-operated device which automatically causes an elevator car to come to a full stop when its floor arrives at the level of the landing floor, irrespective of the weight being carried. The top half of the illustration is a partial side elevational, partial sectional view of the device; the lower half is a vertical sectional view.

Rotating on the ends of two levers at the top of the elevator car are two rolls which, when a door-operated switch is closed, engage two rigid cams, adjustably attached to car guide-way or other convenient adjacent points. These cams are placed at all floors except the extreme top and bottom. In operation, when the car is started in either direction, up or down, the switch is closed when the door is

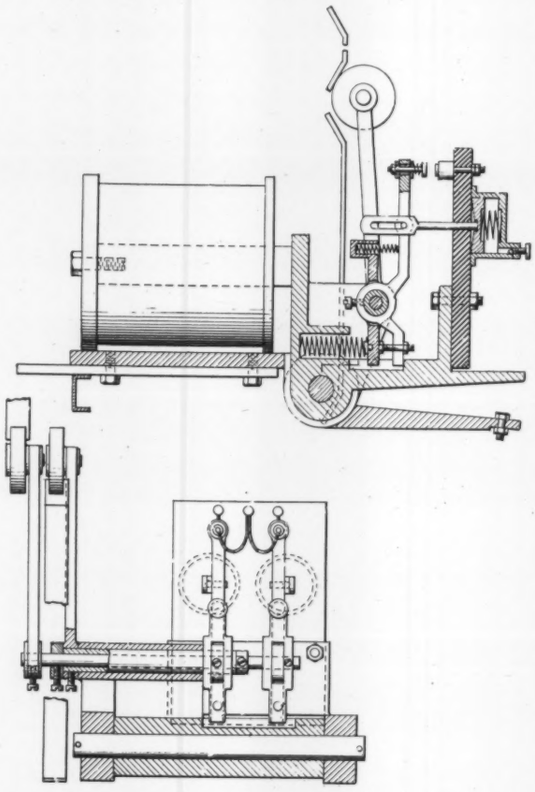


Fig. 2—*Two rolls of elevator device engage two fixed cams to bring car to perfect stop*

shut and the rolls are drawn back to avoid their striking the cams on the floors to be passed.

When the car control lever is moved into neutral position, in order to stop at a floor, an electromagnet is energized, and it draws the switch contacts into operative positions. The rolls then move out and engage the cams.

THE OIL SEAL THAT RESISTS OIL *and* HEAT

PATENTED

SPLIT-KLOZURE

To meet the need for an Oil Seal that can be installed around the shaft rather than over the end of the shaft, Garlock has developed the new patented SPLIT-KLOZURE. For all shafts of 3″ diameter and larger.

The Garlock KLOZURE sealing ring is molded from an exclusive Garlock compound developed specially for oil seal service. It is non-porous, non-abrasive, resilient, tough and durable . . . does not become soft or flabby in service . . . *resists* oil and heat. The KLOZURE Oil Seal is furnished in a complete range of sizes. Write for catalogs.

THE GARLOCK PACKING CO., PALMYRA, N. Y.

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

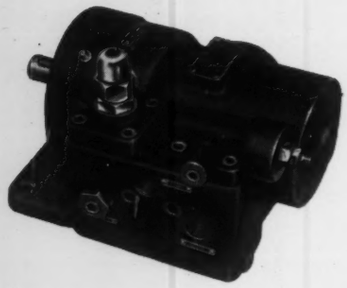
Garlock KLOZURE

NEW Materials and Parts

(For Engineering Department Equipment see Page 67)

Unit Provides Hydraulic Control

AUTOMATIC volume control of hydraulic installations is provided by a double pump and combination valve unit put on the market by Vickers Inc., 1400 Oakman boulevard, Detroit. Output is automatically varied to take care of either large or small volume requirements. During traverse motions the pressure in the working system is relatively low. In effect the new unit has two balanced vane pumps driven by a single shaft with the output of one pump being available to the hydraulic working system under all circumstances and the other automatically cutting in only when needed. When not needed for large volume requirements, the second pump merely recirculates oil with pressure resistance. During the traverse motions the pressure in the working system is relatively low. Low pressure at the unloading valve chamber causes the second pump delivery to join that of the first pump and the combined volume is therefore available for the low pressure traverse motions. Whenever feeding action begins, pressure in the system is built up because of the introduction of a flow-control metering valve into the active circuit. This immediately builds up system pressure, so that the entire volume of the second pump is allowed to discharge to the tank at no back pressure.



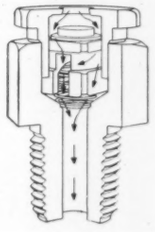
Double pump and combination valve unit gives automatic volume control of hydraulic installations

Sand Cast Aluminum Alloy Announced

A NEW sand cast aluminum alloy known as No. 40 Ti-Aluminum has been announced by Frontier Bronze Corp., Niagara Falls, N. Y. It is close grained, hence suitable for pressure castings, and takes a fine polish which has the appearance of chromium plating. No. 40 alloy does not require heat treating, but instead may be allowed to age at atmospheric temperature. Its tensile strength is 30,000 to 38,000 pounds per square inch, yield point 28,000 to 32,000.

Buttonhead Fitting Speeds Lubrication

DESIGNED to speed lubrication of heavy machinery, a new free-flow giant Alemite buttonhead fitting has been announced by the Stewart-Warner Corp. Bearings requiring large amounts of lubricant can be lubricated in less time than formerly and with less chance of damage to grease gun equipment through overloading. In the new fittings, the usual valve core has been replaced with one which has a flat face and seat and which, when open, offers practically no impediment to the free flow of lubricant. By expanding the diameter of the valve retaining spring, lubricant flows unobstructed through the center of the spring and not through its compressed coils. The improved valve opens easily under slight pressure and provides an effective and tight seal against the loss of lubricant when the pressure is removed. The bodies of the new fittings are hardened to withstand rough treatment. Their smooth tops, which eliminate the cutting or wearing of the coupling sealing washer, are a new feature.

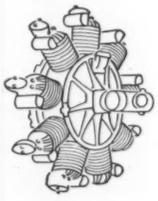


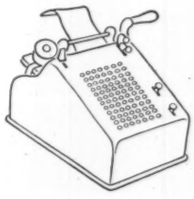
Giant free-flow buttonhead fitting is designed to speed lubrication of heavy machinery

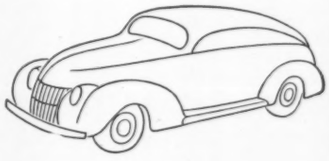
Timer Designed for Built-in Use

DESIGNED for low cost, built-in use, the new series No. 50 automatic timer announced by the Walser Automatic Timer Co., 420 Lexington avenue, New York, is equipped with silver contacts for the control of 15 amperes of alternating current at 125 volts. Switch is normally open and stock timing ranges

FULL ANTI-FRICTION ADVANTAGES AT A MINIMUM COST







YOU CAN GET all the advantages of anti-friction construction in your product by using the Torrington Needle Bearing—at a cost that seldom exceeds that of a plain bushing.

In power tools and aircraft engines, business machines and automobiles, manufacturers have increased product value and lowered costs with this unusual bearing.

Here are some of the advantages which you too can obtain with the Needle Bearing.

You can save space and weight, for the Needle Bearing is small and compact. Load capacity is high in proportion to size—the full complement of needles gives many linear inches of contact to carry heavy loads. The design of the bearing—its long axis and small diameter—allows you to use the simplest form of housing.

You can save assembly time, for the bearing is a single unit, easily pressed into place in the housing bore. The hardened retaining shell holds the needles securely in place and acts as the outer race. In most applications, the shaft itself, accurately machined and properly hardened, forms the inner race.

Your customer will find that the bearing needs little service attention. The retaining shell, with its turned-in lips fitting closely to the shaft, holds ample grease or oil for long periods of operation. The rotation of the needles constantly provides lubricant to the rotating shaft. And with all these features, the bearing is surprisingly low in unit cost.

Why not investigate these advantages in your own product? The Torrington Engineering Department will cooperate with you in laying out bearing applications. For further information, write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Circular No. X from our associate, Bantam Bearings Corporation, South Bend, Ind.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON NEEDLE BEARING

Here's The Drawing Pencil For BETTER REPRODUCTIONS

ARE you satisfied with the clearness and sharpness of the prints you make direct from your pencil drawings? There is no reason why you can't get beauty of line from direct reproductions—if you use Mars LUMOGRAPH drawing pencils.

LUMOGRAPH lead contains a secret light absorbing element that produces a more opaque line, resistant to the light of the blueprinter's equipment, sure to "hold that line" in the reproduction. It is *the* drawing pencil especially created for modern drafting room use.

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Mars LUMOGRAPH lead is unusually strong, resists breaking, holds its point, stays sharp longer and is absolutely gritless. Every lead in every pencil and every pencil in every box is uniform all the way through. Beautifully finished and conveniently marked with the degree on all six sides of the exclusive black tip.

275 years of experience have gone to the making of Mars LUMOGRAPH. The result is that thousands of architects, engineers, draftsmen say that LUMOGRAPH actually does improve their work. Try it—prove it—use it yourself. 17 degrees—15c each—$1.50 the dozen packed in a metal box. If your dealer cannot supply you, send us your order and his name.

Also
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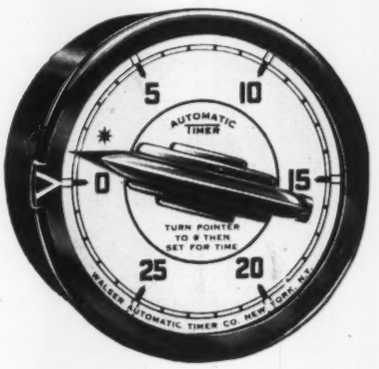
No. 1904 Artist Pencil Lead
and
TRADITION CHROMA Colored Pencils
strong — brilliant
made in 16 special colors.

J. S. STAEDTLER, INC.
53-55 Worth St., New York

MARS LUMOGRAPH

of 15, 30 and 60 minutes are available. The clock mechanism is of the hair spring escapement type. It is operated by means of a Bakelite and nickel pointer which, when turned to an interval, closes the switch circuit and starts the timing mechanism. The housing is of Bakelite and the switch mechanism is mounted

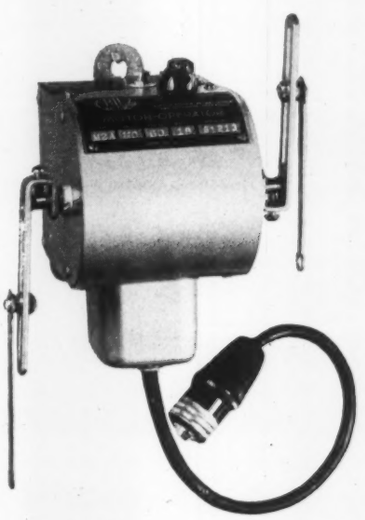


Automatic timer is designed for built-in use, and is equipped with silver contacts for control of 15 amperes at 125 volts

on the inner side of the switch base, with screw terminals on the outer side for wiring connections. Diameter of timer housing is 2⅝ inches; depth, 1¾ inches. By means of a metal ring and three screws, riveted frictionally tight to the ring, the timer is securely clamped to the panel for flush dial installation.

Motor Operator Brought Out

THE motor operator, or damper motor, brought out by Julien P. Friez & Sons Inc., Baltimore, is used to give effect to the automatic control provided by thermostats, pressurestats, and other instruments. Control comes directly from the automatic switching

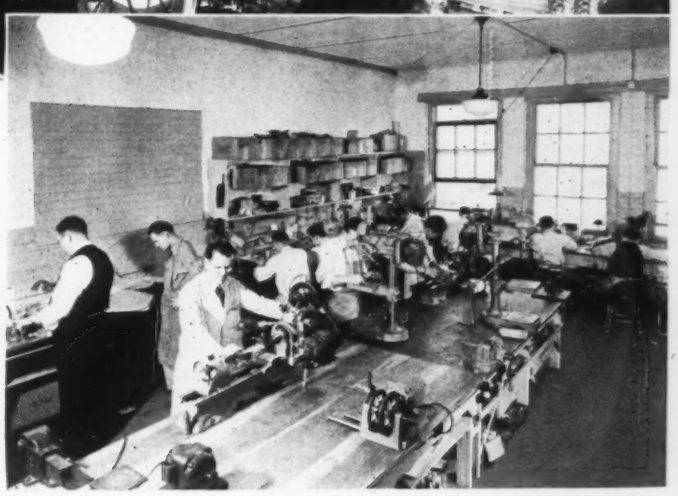


Motor operator gives effect to the automatic control provided by thermostats, pressurestats and other instruments

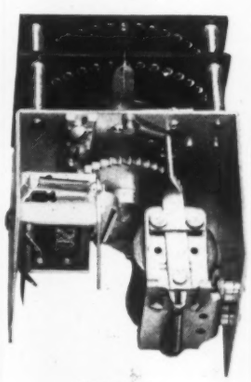
provided by the instrument, without recourse to electrical relays. The motor operator runs on low voltage furnished to the control circuit and motor by the secondary of a simple transformer furnished with each operator. The motor is fitted with an auxiliary hand switch giving "On-Off" or "Automatic" positions, and

ALL NEW RELAYS by GUARDIAN

are PROVEN here--
BEFORE PRODUCTION BEGINS



EXPERIMENTAL DEPARTMENT where a hundred variations of one relay are tested under the most extreme conditions before the final design reaches Guardian's production lines.



TYPE-R STEPPING RELAY

GUARDIAN'S Relay Assembly line in action pictured in the above candid photo, turns out thousands of Relays every day. But before any relay goes into production, Guardian's *Experimental Department* must test it in innumerable ways. We must *know in advance* that your relays will *perform* as expected. A uniform, dependable, faultless product is the natural result . . . ANY QUANTITY AS YOU WANT THEM, WHEN YOU WANT THEM. No complaints . . . no post-mortems.

When seeking a better source for relays, remember it's *not the largest factory* BUT *high quality, fast service,* and *conservative cost* that really count.

Ask Us To Make Specific Recommendations To Fit Your Special Requirements. Write For Catalog D Today!

GUARDIAN ELECTRIC

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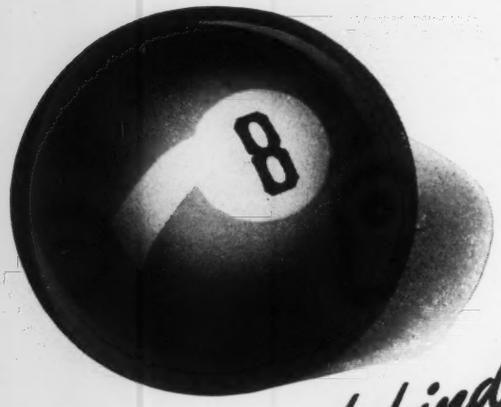


When you're behind the Eight Ball with a Plastics Problem

So highly individualized has the rapid and widespread use of plastics become that Richardson devotes its entire time and resources to the plastics arts, offering to industry an organization with comprehensive production facilities and technical abilities to assist in the application of INSUROK and other plastics to products old and new, and to manufacturing equipment. Learn about the breadth and scope of this unusual Richardson service—and how it can be used to your profitable advantage.

INSUROK

Superior Laminated or Molded Plastic

. . . of known physical, chemical and dielectric characteristics, is available in sheets, rods and tubes, in sizes and gauges, colors and finishes to meet your fabrication requirements, or finished products ready for assembly. Investigate INSUROK, the superior plastic. Literature on request.

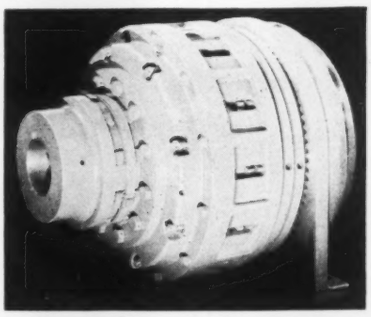
The RICHARDSON COMPANY

Melrose Park, (Chicago) Ill. Founded 1858 Lockland, (Cincinnati) Ohio
New Brunswick, N. J. Indianapolis, Ind.
Detroit Office: 4-252 G. M. Building, Phone Madison 9365
New York Office: 75 West Street, Phone Whitehall 4-4497

arms which are adjustable in position. These arms are connected to the draft damper of coal-fired furnaces of boilers, to the duct dampers of air conditioners, to zone dampers, and to other valve, heating or cooling equipment. Additional types provide heavy auxiliary side switches to operate fans, burners, stokers, compressors, etc.

Magnetic Clutch-Brake Combination

A NEW magnetic clutch-brake combination which has the unique quality of providing a positive clutch, friction clutch and friction brake is announced by the Stearns Magnetic Mfg. Co., Milwaukee. This new clutch-brake combination is styled FFP. It can be engaged at normal motor speed and it is claimed

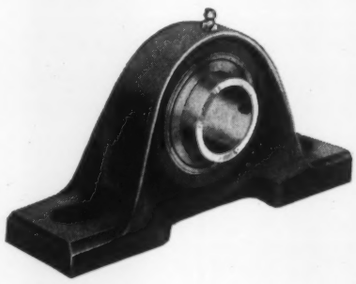


Magnetic clutch-brake combination provides operation of positive clutch, friction clutch and friction brake

to give smooth acceleration, positive non-creep running and split disk brake stopping. This new combination lends itself to simple remote control facilities. One pushbutton for starting and another for running, and any convenient number of pushbuttons for stopping will operate the style FFP. It is particularly adaptable as a safety device on positive drives.

Ball Bearing Pillow Blocks Developed

NEW type of ball bearing pillow blocks has been developed under the tradename Sealmaster by Stephens-Adamson Mfg. Co., Aurora, Ill. Outstanding feature is the permanent seal principle of the bearing,

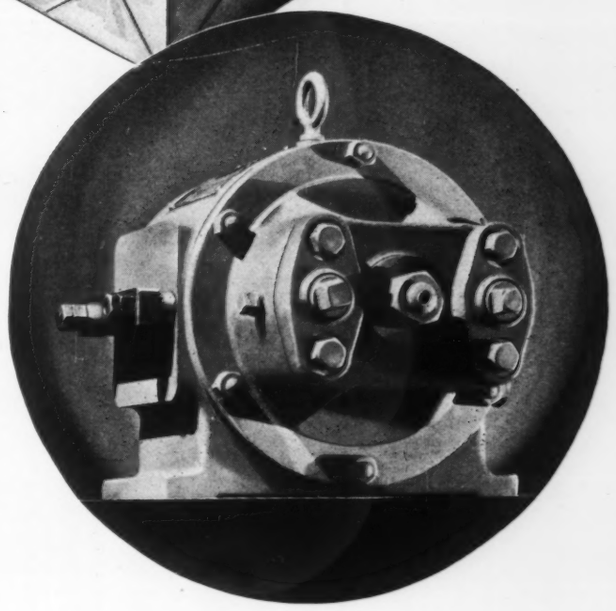


Ball bearing pillow blocks have permanent seal principle, giving positive, centrifugal sealing

a positive, centrifugal sealing principle consisting of two inner and two outer steel seals. Inner seals, one at each side of the bearing, are pressed into the outer ring and become a permanent part of the bearing,

HELE-SHAW FLUID POWER

As *Convenient* to attach as a label to a box



Hele-Shaw Fluid Power is oil under pressure—used, like electric power, for driving machinery. The Hele-Shaw Pump generating the fluid power can be conveniently attached to almost any available place on (or off) the machine it drives. This is a big advantage and one easily explained by the fact that Fluid Power is carried through *pipes* from the pump to the point of application. There are no gears, belts or chains to line up. There are no obstructions Fluid Power can't pass.

Ease of attachment is only one reason why so many machine designers, builders and buyers are specifying Hele-Shaw Fluid Power. But there are other equally important advantages. Hele-Shaw Fluid Power increases production by instant and automatic adjustment to operating conditions, it is easy to control instantly and precisely.

Write in for complete details. **Ask us** to show you how Hele-Shaw Fluid Power can be applied to advantage in the machinery you design, build or buy. Specify Hele-Shaw.

A-E-CO HELE-SHAW *Fluid* POWER

A-E-CO Hele-Shaw FLUID POWER

OTHER A-E-CO PRODUCTS: Lo-Hed Hoists, Taylor Stoker Units, Marine Deck Auxiliaries.

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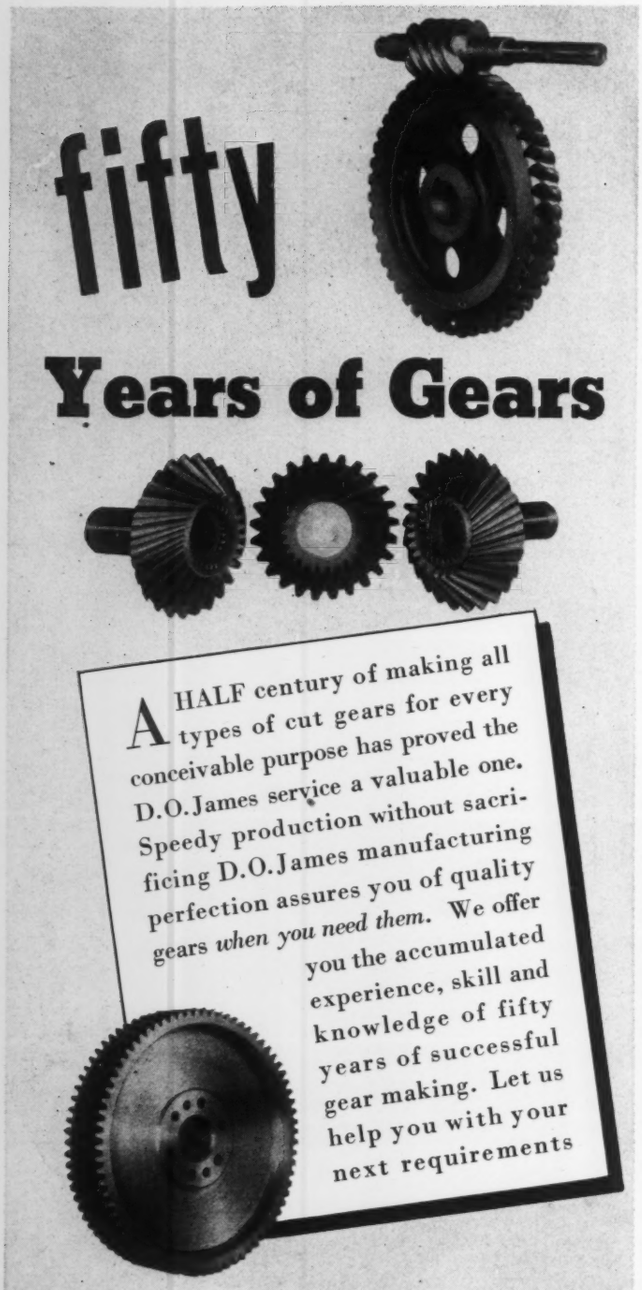
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Years of Gears
A HALF century of making all types of cut gears for every conceivable purpose has proved the D.O.James service a valuable one. Speedy production without sacrificing D.O.James manufacturing perfection assures you of quality gears *when you need them.* We offer you the accumulated experience, skill and knowledge of fifty years of successful gear making. Let us help you with your next requirements
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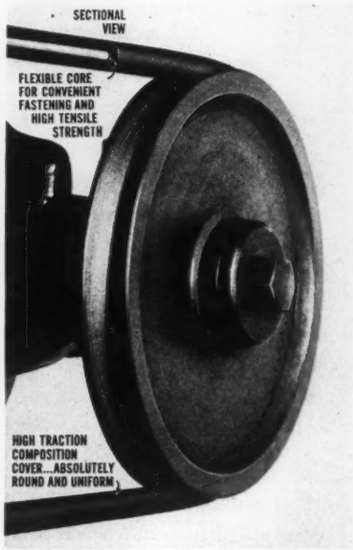
forming a tight grease chamber for race grooves and rolling elements. External flinger seals are pressed into position upon the land of the inner race ring. External seals are lined with felt applied with cellulose cement. Felt liners for external seals travel in labyrinth angular grooves of inner seals. Centrifugal action of dished felt rings rotating in grooved labyrinth inner seals prevents glazing and excludes foreign materials. Even though the bearing is removed from the shaft, the permanent seal feature prevents ingress of dirt. The expansion type ball bearings are self-aligning, self-contained.

Special Core Gives Belting Strength

ROUND composition belting for use on light machinery is now being marketed by Sudbury Laboratory, South Sudbury, Mass. Known as "Round-Tex," the belting has a core made by a special process which gives it high tensile strength and resiliency with practically no permanent stretch. Hence maintenance is greatly reduced. A high coefficient of friction enables the belting to drive machines with low tension. Sold only in 100-foot rolls, Round-Tex is made in three widths: ¼, 5/16, and ⅜-inch. To fasten the ends of the belting it is necessary only to remove two inches of the composition and tie the ends of the core together. Ordinary belt hooks may be used.


SECTIONAL VIEW
FLEXIBLE CORE FOR CONVENIENT FASTENING AND HIGH TENSILE STRENGTH
HIGH TRACTION COMPOSITION COVER...ABSOLUTELY ROUND AND UNIFORM

Core of this composition belting gives it unusual tensile strength combined with permanent resiliency

Strip Heaters Give Convenient Heat

TWO new types of strip heaters designed to produce fast, economical heat have been announced by the Westinghouse Electric & Mfg. Co., East Pittsburgh. Made in two temperature ratings of 750 and 1200 degrees Fahr., these heaters are particularly applicable on crane cabs, valve house, elevators, ovens,

KEEP YOUR PRODUCT FROM GETTING RATTLED

YOU WHO MANUFACTURE PRODUCTS USING SCREWS ARE FORTUNATE TO HAVE IN ONE DEVICE A METHOD OF

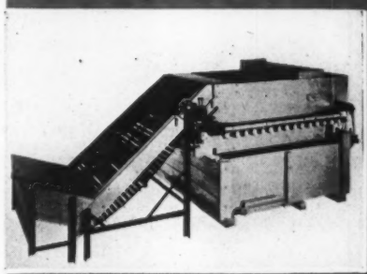
1 saving up to 50% in assembly cost, and

2 building longer life into your products.

The Phillips Recessed Head Screw drives faster and sets up tighter. No danger of driver slipping from the screw's recess, so power drivers are used more often. And the screws — recessed for maximum strength in the head — set up flush without pilot holes, without split heads, without burrs. ¶ There's so much more holding power in a Phillips Recessed Head Screw that you can often use *fewer* or smaller, *lower cost* sizes!

ASSEMBLY COST DOWN . . . SALES VALUE UP

DOUBLE REASONS FOR PHILLIPS SCREWS

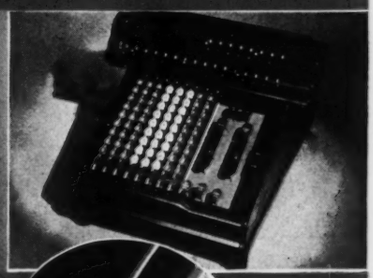


MORE WORK PER HOUR

Manufacturer of fruit and vegetable cleaning equipment finds use of Phillips Screws saves 35% in assembly time.

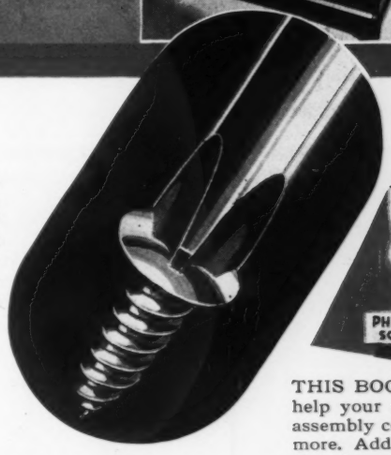
CAN'T LOOSEN

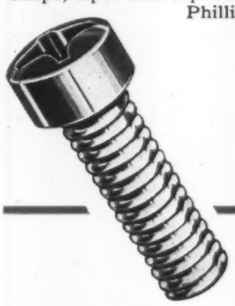
Easier-to-drive Phillips Screws set up flush without heads splitting. Greater resistance to vibration.



PRECISION FIT Stops Fumbling, Crooked Driving, Burrs

The Phillips Recessed Head Screw clings to the driver. The driver centers in the screw's recess, drives straight with one hand free to hold the work. Absence of shearing action means no burrs. Shape, taper and depth of the genuine Phillips recess were determined after months of research. The recess utilizes the driver's maximum turning power without sacrifice of strength in the screw head. Four sizes of Phillips Drivers give best efficiency over entire range of screw sizes. 2 driver sizes fit diameters #5 to #16 inclusive.





PHILLIPS

RECESSED HEAD SCREWS

MACHINE SCREWS · SHEET METAL SCREWS · WOOD SCREWS · STOVE BOLTS

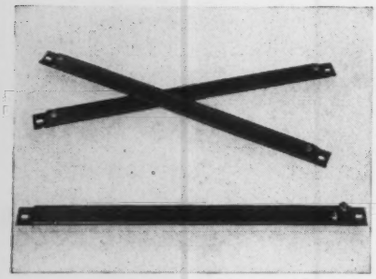
THIS BOOKLET will help your plant to cut assembly costs 50% and more. Address one of the firms below for free copy.

U. S. Pat. on Product and Methods Nos. 2,046,443; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338

American Screw Co., Licensor, Providence, R. I.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corporation, New Britain, Conn.
The Lamson & Sessions Co., Cleveland, Ohio
National Screw & Mfg. Co., Cleveland, Ohio
Parker-Kalon Corporation, New York, N. Y.
Pheoll Manufacturing Company, Chicago, Illinois
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y
Scovill Manufacturing Co., Waterbury, Conn.

IT COSTS LESS TO USE PHILLIPS SCREWS

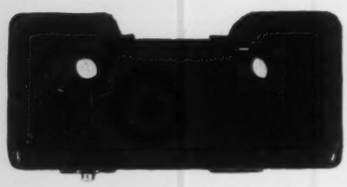
metal water tanks, pipe lines, foundry plants, and wherever ease of application and convenience are requirements. Heaters may be obtained either with both terminals at one end or at opposite ends for installation convenience. Heating elements, with refractory insulation, and sealed against moisture, are completely enclosed with bolt holes at each end for quick and permanent installation.



Strip heaters provide fast, economical heat for places such as crane cabs, valve houses, elevators, foundry plants

Switch for Light Pressure Applications

A PRECISION switch for applications where very light pressure or other small movement is required to operate, has been announced by Electronic Products, 106 East Liberty street, Ann Arbor, Mich. It is housed in a Bakelite molded case. It operates with an actuating movement of 1/1000-inch or less and with pressures of seven ounces or more and will handle current up to 15 amperes alternating current. The switch can be made with two different actuating pin positions, and with special characteristics to suit almost any requirements.



Precision switch for applications where very light pressure or small movement is required to operate

Ignition Welding Contactors Announced

LATEST addition to its line of ignitron contactors for spot injection and flash welders has been announced by General Electric Co., Schenectady, N. Y. The new contactor's advantages include quiet operation, no moving parts, low initial and low maintenance costs. Tubes can be replaced quickly. The new contactor consists of two water-cooled, sealed-off ignitron tubes mounted on a composition panel with the control circuit. The tubes are so connected as to conduct full-wave alternating current to the welding machine when the control switch is closed. Current flow ceases when the control switch is opened. Any type timer can be used to control this contactor. A new flow switch, of the differential-pressure type, assures adequate water cooling when the control is in operation.

Pump Supplies Coolant at Low Head

FOR supplying coolant for machine tools, light machinery and for other installations where a large volume is required at a low head and where dirt or abrasive may be present in the liquid, a centrifugal Motorpump No. 212 has been announced by the Brown & Sharpe Mfg. Co., Providence, R. I. The pump is fitted with a fully enclosed motor and grease sealed ball bearings. Stainless steel shaft is integral with the motor, giving simplicity and strength. The open type impeller is aluminum bronze, hydraulically balanced and designed to allow abrasives to be discharged without excessive wear within the housing. Impeller case is cast iron. The pump is mounted in a tank with a maximum depth of submergence indicated by the water line. The discharge pipe clears the motor and provision is made in the design to prevent rise of liquid in the shaft housing above the level of supply, thus protecting the motor.

Centrifugal Motorpump supplies coolant to machine tools and light machinery where large volume at low head is required

Permanent Split Phase Motor

MAINLY suited for fan, blower, or similar low starting torque service, a new permanent split phase motor operating on alternating current has been announced by Reynolds Electric Co., 2650 West Congress street, Chicago. This type is essentially a shaded pole design; that is, a shaded pole winding is employed, producing a split field and permitting sub-synchronous

(*Continued on Page* 67)

Permanent split phase motor is mainly suited for fan, blower or similar low starting torque service

Why Need Kelly Worry?

KELLY'S days are cluttered with electrical details. His head swims as he wastes time in trying to co-ordinate many makes of electric equipment. It would be so much easier for him to delegate the responsibility for the electrical end of his machines to *one* manufacturer. • Such a delegation would free him for bigger things. He would have time for far more important design or production problems. • You, too, can obtain from General Electric the motors, control, instruments, cable, heating or wiring devices, and many other electric products needed for your machines. Our engineers, moreover, will assume the undivided responsibility for co-ordinating all these devices. • We don't claim, of course, that turning to General Electric will automatically solve every single electrical problem in connection with your machines. We do believe, however, that our engineers can relieve you of many details in co-ordinating equipment. They've alleviated many design-problem headaches. Just phone them at our nearest sales office. General Electric Company, Schenectady, N. Y.

G-E UNDIVIDED RESPONSIBILITY COULD GIVE KELLY

ONE SOURCE FOR ALL ELECTRIC EQUIPMENT

Relying on General Electric would not only save Kelly's time but also assure his obtaining electric equipment with matched electrical characteristics—equipment designed to operate as a unit.

Moreover, no matter where Kelly's machines might go, his customers would find a G-E service shop nearby for all types of electric equipment.

GENERAL ELECTRIC

011-366

Which Type of G-E Gear-motor Do You Need for Your Low-speed Drive?

No matter what type of low-speed drive you may need for your conveyors, mixers, agitators, pumps, or other low-speed machines, a gear-motor is the correct solution.

G-E gear-motors are available in ratings from 1/8 to 75 hp, with output-shaft speeds from 6 to 600 rpm, in polyphase, single-phase, or direct-current types—a type to fill every requirement.

The coupon to the right will bring you two booklets that will describe and explain G-E gear-motors and their applications. General Electric, Schenectady, N. Y.

General Electric Company
Dept. 6F-201, Schenectady, N. Y.

Please send me a copy of each of your two new bulletins, GEA-1437C and GEA-1929A, that will give me complete and detailed information about G-E gear-motors.

Name .....

Company .....

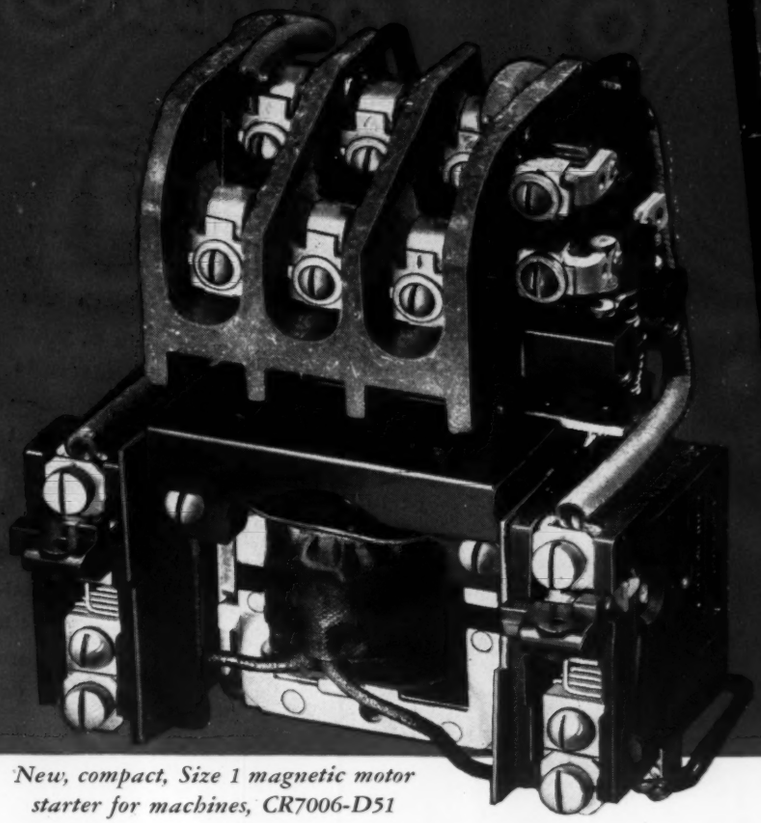
Address .....

City ..... State .....

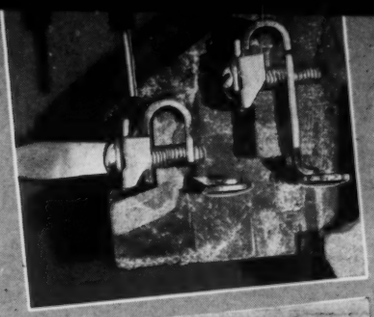
GENERAL ELECTRIC

020-373

For the Designer Who Wants to



New, compact, Size 1 magnetic motor starter for machines, CR7006-D51

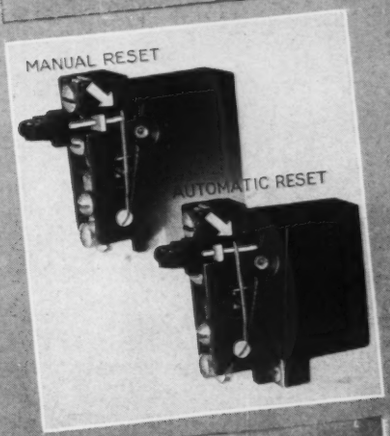


SAVE WIRING TIME

New clamp-type terminals, when tightened, firmly grip straight, bared wire. Eliminates troublesome plier work

SIMPLIFY MAINTENANCE

Movable contact support slips out when two screws are removed. Terminal screw holds stationary contacts fast



ASSURE OVERLOAD PROTECTION

Depend on the new enclosed isothermic overload relays for accurate protection — manual or automatic reset

IF you are interested in saving time for the electrician who wires your machine — if you want users to prefer your machine to others because its control is easy to inspect and maintain — if you want your motors to be protected against overload by an isothermic relay — this new motor starter was *built* for you.

Only 6 inches high by 5 inches wide, it's easy to build in. Yet it conforms to all the standards set by the Underwriters' Laboratories and satisfies the rigorous requirements of G-E design engineers.

Why not write today for the new bulletin describing the CR7006-D51 starter? Or call the G-E office nearest you and ask to see one of these new starters.

GENERAL ELECTRIC

General Electric, Dept. 6-C 201
Schenectady, N. Y.

Please send me your pictorial Bulletin GEA-2964 showing the new -D51 starter and describing its many features.

NAME .....

FIRM .....

ADDRESS .....

CITY .....

680-150

WHY You Should Use "TAILORED" MOTOR PARTS in Your Devices

Ratings from 1/100 hp to 1 1/3 hp at speeds from 5,000 to 10,000 rpm, for either alternating current or direct current up to 250 volts. Parts can also be furnished for speeds below 5,000 rpm

"TAILORED" parts give you and your customers the benefits of series-motor parts that have been designed to meet both the mechanical and electrical requirements of your devices. This proper fitting of motor parts results in satisfactory motor operation and long life—features that you will like to have associated with your products.

General Electric series-motor parts are carefully designed and manufactured to give them the correct characteristics for your applications. High-quality materials, correct design, special processes, and expert workmanship are all combined to give the motor performance that you want your customers to enjoy.

G-E SERIES-MOTOR PARTS FOR DEVICES LIKE THESE

- Drills
- Floor polishers
- Food mixers
- Hair clippers
- Hedge trimmers
- Horns
- Jointers
- Mortisers
- Motion-picture projectors
- Portable tools
- Paint chippers
- Sanders
- Screw drivers
- Sirens
- Shavers
- Tool-post grinders
- Vacuum cleaners
- Valve grinders

DECREASE SIZE AND WEIGHT WITH G-E PARTS

The use of series-motor parts minimizes both size and weight of a unit because the housing and end shields are part of the complete device. Moreover, large outputs are obtained from physically small motors. Why not get G-E series-motor parts for your devices? These carefully built and carefully tested parts are available in the following types:

NORMAL-SERVICE PARTS

For high-speed applications where duty is intermittent, where constant speed is not required, and where the load is fairly constant; for example, domestic mixers, vacuum cleaners, and similar devices that limit light-load speed and do not operate without load.

HEAVY-DUTY PARTS

For tools, such as drills and saws, where speeds are high and overloads may be severe for short periods. They are built for unusual service conditions—windings are moisture-resistant and firmly bonded to withstand high speeds.

COMPENSATED PARTS

For devices requiring better speed regulation, greater starting torque, and greater output than can be obtained with heavy-duty parts. They differ from the latter in the construction of the field.

G-E engineers will be glad to help you select the correct parts for your application and in designing your device so that adequate ventilation is obtained for the motor. For information, call the nearest G-E sales office or address General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

(*Continued from Page* 62)

operation. This phase-splitting winding eliminates the need for a centrifugal start switch since it is permanently connected to the main winding. To obtain speed variation the applied voltage is varied by a rheostat or a tapped choke coil. This type motor has rather low starting torque, relatively efficient full load characteristics and a fairly high breakdown torque. Temperature rise is approximately 55 degrees.

Gate Valve Covers Corrosion Uses

AVAILABLE in a wide range of alloys to cover almost any severe corrosion application, a new gate valve has been announced by Alloy Steel Products Co., Linden, N. J. A feature is the outside screw and yoke, combined with extremely flexible wedge construction. The wedges in these valves are of the double disk, ball and socket type, held by an arm which is threaded and pinned to the stem. Disks are free to rotate and are non-fouling in any position. Seats are integral with bodies. Bonnets are clamped to bodies by through bolts with heavier bolting in larger sizes. These valves are easily taken apart for cleaning and may be repacked under pressure when wide open.

Gate valve with flexible wedge construction is available in a wide range of alloys to cover corrosion applications

Fluorescent Lamp Gives Ample Light

FOR general industrial lighting, General Electric Vapor Lamp Co. has developed a tubular 100-watt fluorescent lamp, 4 feet in effective length. Inside of the tube is coated with a special fluorescent material which converts ultraviolet radiations produced in the tube to visible light by means of a high ratio energy transformation. Efficiency of this lamp is great, being 50 lumens per watt, or roughly three times that of equivalent wattage from incandescent light sources.

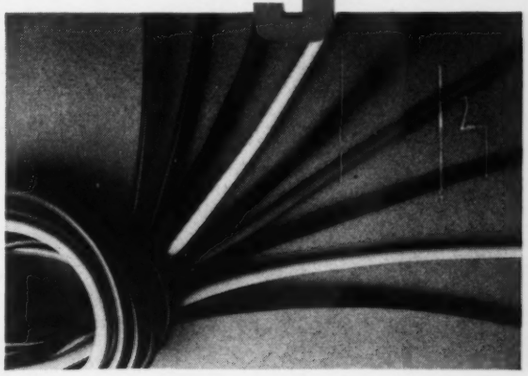
White Printer, Developer Combined

MODEL E white print machine has been brought out by Ozalid Corp., New York. A developer is combined in the unit, so that no other equipment is necessary. The machine will handle all Ozalid sensitized materials up to and including 42 inches in width

FLAMENOL WIRE

REG. U.S. PATENT OFFICE

COMES IN 9 COLORS



Easy to Identify Circuits

RED
WHITE
Lt BLUE
Dk BLUE
GREEN
YELLOW
BROWN
PURPLE
BLACK

WHAT other wire can you get in so many different clear bright colors! Even additional means can be furnished to identify circuits. The covering, Flamenol, can be ridged.

And this is but one of many features peculiar to Flamenol. It won't burn; it resists oil, acids, and alkalis; it has high dielectric and mechanical strength and thus serves both as insulation and finish.

For these reasons, it has proved ideal for wiring machine tools and other high-grade equipment where its properties are the only ones that fully meet conditions. Bulletin GEA-2733 gives details. For a copy address nearest G-E sales office or General Electric, Dept. 6—201, Schenectady, New York.

INSULATED WIRE ALWAYS THE RIGHT TYPE FOR EACH JOB

GENERAL ELECTRIC

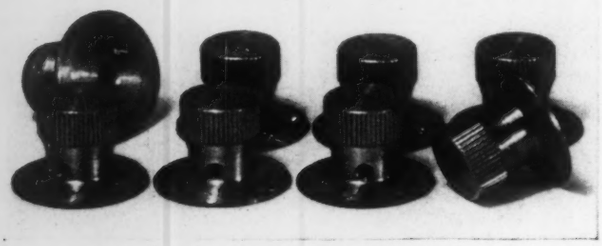
520-149

Photo courtesy The Heald Machine Co.

AVIATION'S NEW TYPE OIL LINE HOSE NOW ADAPTED TO MACHINE TOOL APPLICATIONS

Several leading machine tool builders now specify AVIOFLEX. Completely impervious internally to hot hydrocarbon fluids due to use of laminated cellulose sheets wrapped over a specially profiled flexible metal core. Also resistant externally to hot oils. AVIOFLEX construction assures great strength, practically unlimited flexing life. Data, sample, on request.

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS



"KNOBS!"

Smartly designed brass focal plane shutter speed knobs. Completed on the automatic except for tapping and marking. A clean-cut, well-finished job for an outstanding modern camera, and indicative of many other parts and accessories which "Peck Service" has produced, speedily and economically, for high grade instruments, appliances and special devices. But whether your product is in this classification or just an article for popular sale, it will pay you to

SEND FOR THE PECK CATALOG

—a book of much value to designers, engineers and purchasing agents. No charge, but please make request on your letter head.

PECK SPRINGS
AND SCREW MACHINE PARTS
The Peck Spring Co. 10 Wells St. Plainville, Conn.

at speeds up to 30 linear inches per minute. The printer includes a rotating glass cylinder, providing rolling contact and insuring maximum utilization of the light rays emitted by a single mercury vapor tube. Constant cleaning is obviated because all air entering the cylinder for cooling the tube is filtered to minimize dust deposits on the burner within the cylinder. Routine cleaning can be easily effected by simply sliding the tube out of the cylinder after disconnecting

White print machine includes developer, hence no other equipment is necessary to handle fully sensitized materials up to 42 inches in width

a single polarized four-prong plug. As soon as the developer is turned on, ammonia is automatically admitted to the developing tank in the proper metered quantities. A separate switch disconnects the automatic drip feed in case it is desired to vary the flow of aqua ammonia by manual operation. The machine is driven by a ¼-horsepower resilient-rubber mounted split phase motor, and the speed adjustment of the printer is infinitely variable from ½-inch to 30 inches per minute.

Light Nonferrous Alloy Announced

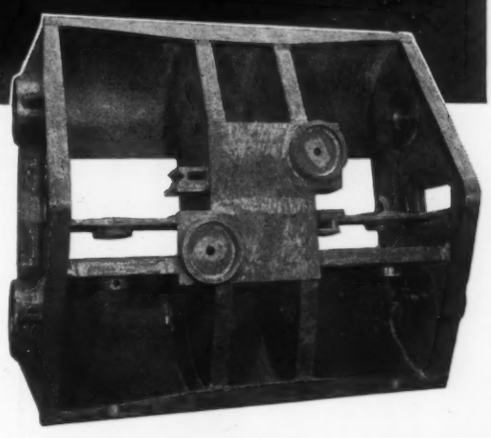
COLALLOY, a metal two-thirds lighter than steel, with corrosion resistance, electrical and thermal conductivity, and good working properties, has been announced by Colonial Alloys Co., Philadelphia. Included in Colalloy's composition are aluminum, magnesium, manganese, silicon and occasionally copper and chromium. This metal is available in the forms, shapes, gages and range of sizes of most common metals. Nonrusting, Colalloy's salts are colorless, odorless, nontoxic, tasteless and noncontaining.

Triple Seal Protects Bearing

EFFECTIVELY protecting the bearing against lubricant leakage, dust, dirt and moisture, a triple seal has been put on the market by SKF Industries Inc., Philadelphia. This seal consists of two split piston rings on each side of the housing and grooved

HOW TO BUILD EQUIPMENT THAT

Won't Break Down!



INSURANCE AGAINST BREAKDOWNS. This clean-up coal bucket with scoops 9 ft. wide and 24 ft. spread is constructed of U·S·S MAN-TEN Rolled Steel throughout. All details, with the exception of the main frame which is unsuited for heat treatment, are welded construction. Dozens of rolled-steel-built buckets like this have proved their ability to stand up under the most severe service. Photographs—Courtesy of the Wellman Engineering Co., Cleveland, Ohio.

LIGHT — UNIFORMLY STRONG THROUGHOUT. Sheave Block for clean-up bucket using MAN-TEN with complete penetration welds (stress relief annealed). This design and the use of High Tensile Steel made substantial saving in weight possible.

Here's one way — *build it of the right kind of* **ROLLED STEEL** *— used in the right place*

"WRITE your own guarantee against breakage," say the builders of these material handling units. Their clam shell buckets, they claim, are built so strong, so resistant to tension, bending, fatigue and impact that " the customer, in effect, gets an insurance policy with every bucket."

What is their secret of success in building breakdown-proof machinery? Briefly this. These people are specialists in welded rolled steel construction. They know the heartless punishment their equipment must withstand. And, most important of all, they *know* from experience exactly *what kind* of rolled steel to use—and *where* to use it to get the best results.

They use U·S·S COR-TEN where they want to reduce dead weight and increase resistance to atmospheric and brine corrosion . . . U·S·S MAN-TEN to obtain increased strength at low weight . . . U·S·S Abrasion Resisting Steel where abrasive wear is severe . . . other special steels to meet other special needs. They freely combine one steel with another in the same design. Or they combine these steels with castings when such combination seems desirable.

Our experience in helping this fabricating company select rolled steels of the right analysis to simplify fabrication and insure the ultimate in service, is yours for the asking.

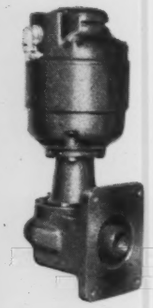
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Now

A PRECISION BUILT GUSHER COOLANT PUMP

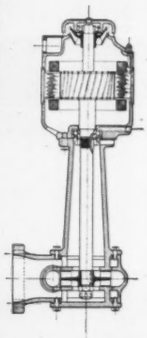
Eliminating Unsightly External Piping



Model No. 11020A

Easily mounted, full ball bearing equipped, HYDROSTATICALLY BALANCED, self cleaning, increased efficiency. Designed for the safe handling of materials that contain grit and abrasives.

QUIET



Model No. 11022 with either two or three phase motor

Write for Engineering Data and Specifications

•

Ruthman Machinery Co.

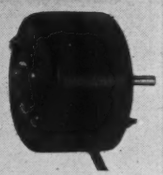
LARGEST BUILDERS OF COOLANT PUMPS

Cincinnati, Ohio

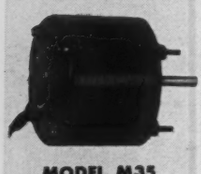
VICTOR

Super-Power

MOTORS



MODEL M41



MODEL M35

MODEL M6

SHADED POLE . . .

. . . Induction Type

Victor offers an outstanding line of quality-built motors of fractional power ranging from 1/200 to 1/10 H. P. Ideal for such applications as fans, blowers, animated displays, timing devices, etc. Years of successful motor building — equipped to solve difficult engineering problems. Write for literature today!

Manufacturers' Representatives:
A few territories not yet assigned. If interested, write us at once.

VICTOR ELECTRIC PRODUCTS, INC.
844 Reading Road Cincinnati, Ohio

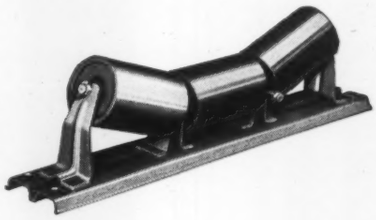
on the outside diameter to form a labyrinth seal with two end bores of the housing. Each ring has an inward tension that enables it to turn with the shaft. On either side of the housing, two rings are mounted on the shaft with the splits 180 degrees apart to prevent lubricant leakage through the splits. The inner

Triple seal protects bearing against lubricant leakage, dust, dirt, moisture

ring serves as an internal flinger, and the outer ring keeps dirt and other foreign substance from entering the housing. The triple seal is made for the complete range of standard shaft sizes and is designed for split housings which are machined to allow axial freedom of the bearing. These housings are sturdy and designed to accommodate various shaft diameters.

Ball Bearing Idler for Conveyors

LINK-BELT CO., Chicago, has developed a ball bearing idler, designated type 90, for belt conveyors handling materials of medium weight consisting of fines and small lumps. It is suitable for conveyor widths of 14 to 24 inches. Idler rolls are made from 4-inch diameter smooth-finished steel tubing with formed heads pressed into and welded to each end and fitted with ball bearings enclosed in a grease-



Ball bearing idler for belt conveyors handling materials of medium weight consisting of fines and small lumps

sealed labyrinth. The rolls are mounted close together in reinforced steel brackets welded to a steel mine-tie base, the ends of which have slotted holes permitting convenient adjustment on the supporting framework. The rolls are rounded and smooth, preventing injury to conveyor belt and may quickly be removed. Since the space between the rolls is very small, creasing of the belt is avoided.

• • • *Machine Design* will carry the Third Annual supplement on "Machine Drives and Controls". Full information on developments and new applications will be given. Concise yet complete presentation will bring engineering data files up-to-the-minute in usefulness.

MACHINE DESIGN

Now

KOH-I-NOOR

Drawing Pencils

ARE

10¢ each

$1.00 the dozen

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Send for our latest catalog M-4

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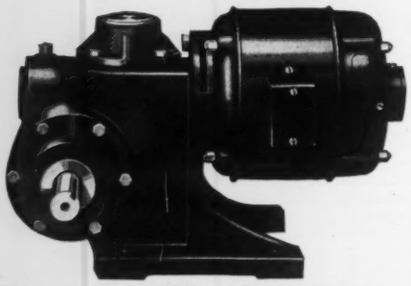
KOH-I-NOOR PENCIL COMPANY, Inc.
373 Fourth Avenue New York, N. Y.

Janette

MOTORIZED SPEED REDUCERS

10 DIFFERENT STYLES
DESIGNED, BUILT, TESTED—Guaranteed
as a Complete, Compact Unit,
by One Organization—
No Divided Responsibility



Illustrating Type LWD—A Double Reduction—Worm Gear—Slow Speed Reducer

The diversity of the Janette custom built line of motorized speed reducers enables us to supply a machine from 1/50 to 7½ H.P. for almost any purpose. You can select the style of compact, rugged Janette speed reducer that meets your individual requirements, without the necessity for using expensive adaptors or modifications.

MAY WE HAVE YOUR REQUIREMENTS

Rotary Converters—Generators—Motors—Motor-Generators

Janette Manufacturing Company

556-558 West Monroe Street Chicago, Ill. U.S.A.

BOSTON - NEW YORK - PHILADELPHIA - CLEVELAND - MILWAUKEE - LOS ANGELES
DETROIT - SEATTLE

Meetings and Expositions

Jan. 6-14—

National Motor Boat Show. To be held at Grand Central Palace, New York. Henry R. Sutphen is president of the National Engine and Boat Manufacturers, 420 Lexington avenue, New York, sponsors of the show.

Jan. 9-13—

Society of Automotive Engineers Inc. Annual meeting to be held in Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary and general manager.

Jan. 16-19—

First All-Industry Refrigeration and Air Conditioning Exhibition to be held at Hotel Stevens, Chicago.

Jan. 16-19—

Coin Manufacturers Association of America. Coin machine show and convention to be held at Hotel Sherman, Chicago. Jas. A. Gilmore, 610 West Van Buren street, Chicago, is secretary-manager.

Jan. 22-27—

Canning Machinery and Supplies association. Annual meeting to be held at Chicago. S. G. Gorsline, Lock Box 430, Battle Creek, Mich., is secretary.

Jan. 23-26—

American Society of Heating and Ventilating Engineers. Refrigeration and air conditioning accessories exhibition and annual meeting to be held at William Penn hotel, Pittsburgh. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

Jan. 23-27—

American Institute of Electrical Engineers. Winter convention to be held in New York. H. H. Henline, 33 West Thirty-ninth street, New York, is secretary.

Jan. 24—

Canning and Packing Machinery institute. Annual meeting to be held in Chicago. E. G. Vail, 205 West Wacker drive, Chicago, is secretary.

March 14-18—

American Society of Tool Engineers. Machine and Tool Progress exhibition to be held in Detroit. Ford R. Lamb, executive secretary, 5928 Second avenue, Detroit, is show manager of the exhibition.

MANUFACTURERS' *publications*

ALLOYS (MAGNESIUM)—Magalloy, an alloy having only two-thirds the weight of aluminum and one-fifth that of steel, is described in a booklet issued by Magnesium Fabricators, Adrian, Mich. Physical and mechanical properties of various grades are given.

BEARINGS—Descriptions and specifications of various types of standard quill bearings are given in bulletin No. 103 published by Bantam Bearings Corp., South Bend, Ind.

BEARINGS—Designers considering tapered roller bearings will find helpful the engineering handbook just published by the Ahlberg Bearing Co., Chicago, exclusive distributors for Bower Roller Bearing Co., Detroit.

BEARINGS—New Departure division, General Motors Corp., Bristol, Conn., has published the 1939 edition of its ball bearing interchangeability tables in booklet form, designated as R5.

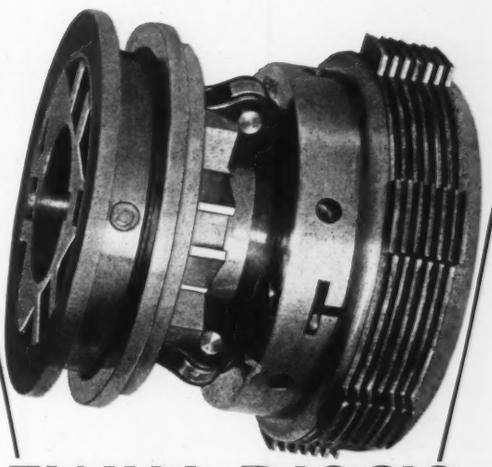
CONTOUR SAWING—The 150-page handbook on contour sawing, published by Continental Machine Specialties Inc., Minneapolis, is of interest to designers because it shows how this method of fabricating can be used for machine parts.

CONTROLLERS—Catalog No. 35 published by Fisher Governor Co., Marshalltown, Iowa, gives complete details on controllers, regulators, valves, traps, etc., for many types of uses.

CONTROLS (ELECTRICAL)—An illustrated booklet issued by Westinghouse Electric & Mfg. Co., East Pittsburgh, announces a new Weld-O-Trol electronic power switch for controlling the primary of welding transformers and for other uses.

CONVEYORS (SCREW)—The new Rex screw conveyor line made by Chain Belt Co., Milwaukee, is described in a catalog containing information on installations, selection of screw conveyors, capacity charts, specifications.

DRAFTING MACHINE—Touch-Control drafters are described in an illustrated circular, No. 100, published



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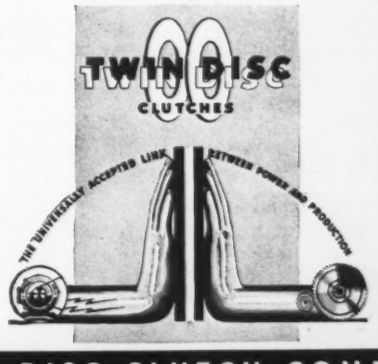
NEW MT CLUTCH

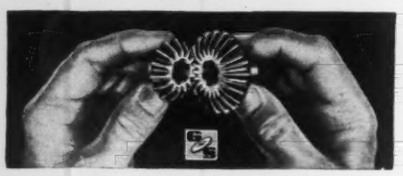
Engineered for the finest machine tools and similar machinery, where space is limited, Twin Disc's new MT Clutch is relatively low in cost. It sets a new high for dependable performance, ease of adjustment and long life. It holds the load as tightly at high speeds of rotation as well as at low. Its fine, positive, single-point adjustment assures the maximum capacity with minimum pressure on the operating lever. Truly a fine clutch, it is of course made to close tolerances with all operating parts carefully hardened. Nine sizes are available ranging from 3 to 8 inches, single or duplex units, dry or run-in-oil types. Ask Twin Disc's engineers to recommend the proper clutch for the load peculiarities of your machine. Twin Disc Clutch Company, 1325 Racine Street, Racine, Wis.



TWIN DISC CLUTCH COMPANY

Small

MITRES-BEVELS 10 to 48 D.P. under 6" P.D.



The very latest development in Small Bevel Gear Generating machines are at your disposal here to make such Gears *right* in every particular . . . What are your requirements?

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Made to order only No stock No catalog

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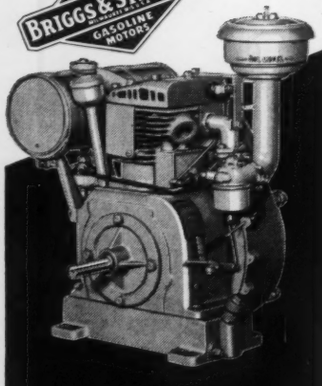
Simplify YOUR POWER PROBLEM

You can simplify your gasoline power problem with Briggs & Stratton—the world's finest small motors—endorsed by more manufacturers than any other make—and you can solve your service problem because of Briggs & Stratton authorized factory trained service shops in every key city throughout the U. S. and Canada. A broad line of models — designed for easy installation — dependability, long life, and economy — make it easy to find a Briggs & Stratton 4-cycle, air-cooled gasoline motor, ½ to 5 H.P., that is best suited to your individual requirements. We will gladly send you detailed information and specifications upon request.
BRIGGS & STRATTON CORP., Dept. MD-1, Milwaukee, Wis., U.S.A.

4 CYCLE BRIGGS & STRATTON GASOLINE MOTORS

MODEL "K"
3 H.P. at 2300 to 2700 R.P.M.
(over 25% reserve power)

Standard equipment includes: oil-bath air cleaner, gasoline filter, specially designed dust and moisture-proof high tension flywheel magneto, compression release (crank starter models only) gasoline tank and fittings, screened blower housing, muffler. Special "K" types also available: 4 to 1 or 6 to 1 gear reduction drives; crank cases machined and tapped for direct mounting with crankshaft in ball bearing on drive side; automatic plain or ball bearing pulley clutches; light-weight, etc.



by Charles Bruning Co. Inc., New York. Smoothness, speed, accuracy, are advantages claimed.

DRIVES (CHAIN)—Ramsey Chain Co. Inc., Albany, N. Y., has published catalog No. 638 covering its mechanical power transmission equipment, and illustrating various high speed chain drive installations.

DRIVES (ROLLER CHAIN)—Rex roller chains and sprockets for chain applications requiring high speed, compactness, quiet operation and efficiency, are described in catalog No. 333 published by Chain Belt Co., Milwaukee.

ELECTRICAL TOOLS—Information for designers on the uses and purposes of electrical tools in fabrication is given in a comprehensive catalog published by The United States Electrical Tool Co., Cincinnati, O.

FASTENINGS—A chart covering drill and reamer sizes for dowel pins has been published by Danly Machine Specialties Inc., Chicago.

FASTENINGS—Different types of hardened self-tapping screws are illustrated and described in an attractive new catalog published by Parker-Kalon Corp., 200 Varick street, New York.

FORGINGS—A well illustrated booklet has been published by The Steel Improvement & Forge Co., Cleveland, giving suggestions on designing for forgings, advantages of forged parts, examples and a list of uses and specifications.

HOSE (FLEXIBLE)—Flexible Metal Hose & Tubing Institute, 150 Broadway, New York, has published a booklet presenting a factual story of these products and showing their usefulness in many design and construction problems.

INSTRUMENTS—A new line of "9" recorders and recorder-controllers is announced in a bulletin, No. 1178, just printed by C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

PLASTICS—The story of Plaskon molding material is told in a booklet, "Molded Color," just published by Plaskon Co. Inc., Toledo, O. Various uses are discussed and physical properties listed.

RUST PROOFING—The Parkerizing process of rust prevention for iron and steel is explained in a new catalog published by Parker Rust Proof Co., Detroit. Advantages of the process are discussed.

SPEED REDUCERS—Bulletin 22-7 issued by Janette Mfg. Co., Chicago, illustrates ten different styles of

motorized speed reducers ranging from 1/50 to 7½-horsepower.

STEEL (SHEET)—American Rolling Mill Co., Middletown, O., has issued an illustrated catalog describing its Armco electrical sheet steels for use in electrical manufacturing.

STEEL (SHEETS)—A 12-page folder, Adv. 312, issued by Republic Steel Corp., Cleveland, entitled "Why Should I Use Republic Galvannealed Sheets?" includes details on advantages of these sheets, as well as information on their properties.

SWITCHES (MICRO)—Complete information on metal-clad micro switches, listing uses and specifications, is given in bulletin No. 19 just issued by Micro Switch Corp., Freeport, Ill.

TRANSMISSION (VARIABLE SPEED)—A new folder has been issued by Ideal Commutator Dresser Co., Sycamore, Ill., describing its Select-O-Speed transmission, as well as other products.

VALVES (SOLENOID)—Davis Regulator Co., 2523 South Washtenaw avenue, Chicago, is offering new bulletin No. S-1, illustrating and describing Davis solenoid valves which can be used for automatic control service on steam, air, gas and liquid.

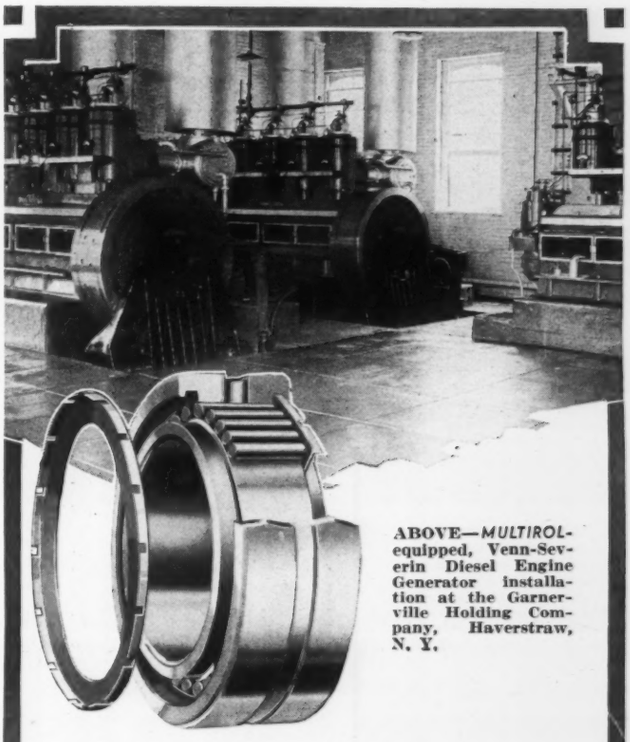
VALVES (STAINLESS STEEL)—Alloy Steel Products Co., Linden, N. J., has published a catalog illustrating and describing Aloyco stainless steel valves and fittings, available in virtually any stainless analysis.

VARIABLE SPEED TRANSMISSION—A self-contained mechanical speed-reducing transmission with speed infinitely and instantly adjustable is described in a new catalog issued by The Lenney Machine & Mfg. Co., Warren, O.

WELDING—A 4-page illustrated booklet published by Westinghouse Electric & Mfg. Co., East Pittsburgh, announces a new Weld-O-Trol electronic power switch for controlling the primary of welding transformers and suitable for use with existing timing devices and for welding mild steel products and other readily welded metals.

WELDING (HARD-FACING)—Haynes Stellite Co., unit of Union Carbide & Carbon Corp., has just revised a folder presenting the complete procedure for hard-facing steel wearing surfaces by the oxyacetylene process. Additional information on different grades of Haynes Stellite hard-facing rod and applications is useful to engineers.

WHITE PRINTER—New Model E white print machine, which combines a developer, is described and illustrated in a folder issued by Ozalid Corp., New York. Specifications are listed.



ABOVE—*MULTIROL*-equipped, Venn-Severin Diesel Engine Generator installation at the Garnerville Holding Company, Haverstraw, N. Y.

Keeping Wheels Turning with

McGILL

MULTIROL

Precision Needle Bearings

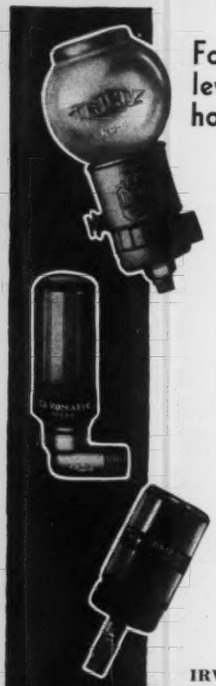
Eliminate bearing troubles and replacements and you go a long way toward truly uninterrupted service, whether it be sewing machines, automobile engines or steam locomotives. McGILL *MULTIROL* Precision Bearings show finest records in these respects, have ever since they were introduced as the original needle type over eight years ago. Especially under sustained heavy or intermittent shock loads, their great load capacity in proportion to their overall size enables them to far outrun plain bearings and ordinary anti-friction types in many uses. Corrosion, heat resisting and other types gladly engineered to special requirements. Write for Bulletin No. 37 and list of stock sizes.

McGILL MANUFACTURING CO.

Bearing Division, 1450 N. Lafayette St.

VALPARAISO, IND.

TRICO REG. U.S. PAT. OFF. AUTOMATIC OILERS



For maintaining a constant level of oil in bearings, gear housings, line shafts, etc.

- They modernize your equipment
- Give that added sales feature
- Reduce selling resistance
- Guarantee proper lubrication of your equipment after it leaves the factory
- Places you a step ahead of your competitor who still thinks the old-fashioned oil can method is good enough.

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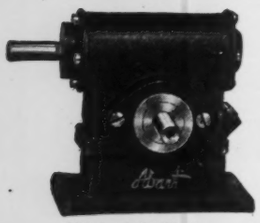
Efficiency? Strength? Compactness? Long Life? Trouble-free Operation? Quietness?

You get all these advantages and *more* when you buy or specify ABART SPEED REDUCERS. They are so ruggedly constucted that they will withstand the most severe punishment encountered in ordinary service without injury. They are the last word in low cost power transmission, and are lighter per *H. P. delivered.* This means that structural bases can be less massive. Write for catalog of complete line.



1½ and SA Unit Horizontal Worm Gear Drive

GEARS Cut gears—all kinds—any quantity. Send blue print or specifications for estimate.

Abart GEAR AND MACHINE CO.
MANUFACTURERS OF
Speed Reducers & Gears
4821 WEST 16th ST CHICAGO ILLINOIS

Topics

(*Concluded from Page* 20)

screen on which to project test letters, Polaroid spectacles, and a cross slide equipped with Polaroid lenses for use in the projector. By harnessing light rays with Polaroid, it is possible to cut off a subject's line of sight between either eye and letters projected on the chart, without the subject's suspecting it. In other words, he doesn't know which eye is seeing. Faking an injury in either eye then becomes impossible. A recent practical test—a $50,000 damage suit in Akron, O.—was settled through use of the equipment.

♦

SPECIAL machines were developed for the continuous production of new type rayon yarns in the Painesville, O., plant of the Industrial Rayon Corp., opened recently. More than $2,000,000 was spent in making and testing the machines before installation. Windowless, the plant provides for the entrance of sunlight through wall panels and monitors of glass block, 371,000 units being used.

♦

MECHANICAL wear of metals is important in almost every phase of engineering, particularly in the design of bearings. It has been difficult, however, to predict. During the recent annual meeting of the American Society of Mechanical Engineers, L. M. Tichvinsky, Westinghouse research engineer, described a technique known as the electron-diffraction method. It is unusually well adapted to studies of mechanical wear because electrons, unlike X-rays, are easily deflected by atoms in any aggregate of matter on which they impinge, and their penetration is limited to the surface layers. In practice a beam of electrons moving at a speed about half that of light is bounced off the surface under examination, and the direction of the diffracted rays leaving the surface is recorded photographically as a so-called electron-diffraction pattern. Since these diffractions are determined by the manner in which the atoms of the material are arranged in the surface layers, the structure of the surface may be determined from the diffraction pattern.

♦

TESTIMONY to the ability of mining engineers and equipment manufacturers to overcome diminution of rich mineral deposits is offered in a monograph prepared by WPA in co-operation with the United States bureau of mines. Because the "cream" of many ores has been removed, the problem has arisen of working grades which were formerly considered virtually worthless. Technical progress has led to greater output per worker in all major metals.

Business and Sales Briefs

TIMKEN ROLLER BEARING CO. has appointed Walter Jehu, formerly general manager of the Timken company in Toronto, Ont., as district manager of the company's office located at 1107 Commonwealth avenue, Boston.

♦

Air-Maze Corp., Cleveland, has moved to its new offices and factory at 5200 Harvard avenue.

♦

Lloyd E. Arnold, who has been with the P. R. Mallory & Co. Inc., Indianapolis, for more than two years, has recently been named manager of the Detroit division of the firm.

♦

J. K. Garretson has been appointed district sales manager for Republic Steel Corp., in its Denver office.

♦

Bliss & Laughlin Inc., Harvey, Ill., has transferred Clyde Llewelyn from Buffalo to take charge of sales and engineering in Hartford, Boston, New York and Philadelphia territories.

♦

W. F. Bender has been made sales engineer for Ohio Steel Foundry Co., covering Pennsylvania and West Virginia. Mr. Bender was formerly with General Alloys Co.

♦

Frank A. Frey has been elected president and treasurer of Geuder, Paeschke & Frey Co., succeeding the late Charles W. Paeschke. Henry P. Millman has been made executive vice president and general manager, while A. G. Paeschke has been re-elected secretary of the company.

♦

Until recently Michigan district manager of Logan Gear Co., Arch Warner has now become affiliated with Mechanics Universal Joint division of Borg-Warner Corp.

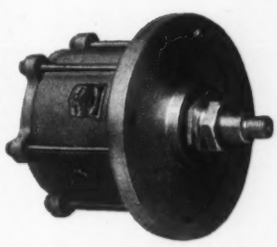
♦

Since 1927 district engineer of the New York district of General Electric Co., T. F. Barton has been appointed assistant manager of the New York district. Having considerable experience in electrical engineering, Mr. Barton has twice won the Charles A. Coffin Foundation awards for outstanding contributions to the electrical industry.

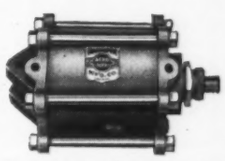
♦

Appointment of Industrial Machinery Co., 3008 First avenue North, Great Falls, Mont., has recently been made to handle the Allen-Bradley line of motor control equipment in Montana and Northern Idaho territories. West L. Powell is in charge. Allen-Bradley

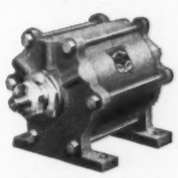
Hannifin Cylinders
ARE BORED AND HONED



Model JR—double acting air cylinder



Model BR—double acting air cylinder



Model CR—double acting air cylinder

● The straight, round, smooth cylinder bores produced by Hannifin boring and honing operations, and the easy adjustment of piston packing provide for a perfect piston seal that can be consistently maintained.

"Leak-proof" design allows simple outside adjustment of the soft, graphite treated piston packing, without disturbing any other parts. The original high efficiency piston seal can be maintained throughout the entire life of the packing.

Built in a full range of standard types, sizes 1½ to 16 in. diameter, for any length stroke. Larger sizes built to order. Single or double acting types, with or without air cushion. Write for Bulletin 34-MD with complete specifications.

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ENGINEERS • DESIGNERS • MANUFACTURERS
Pneumatic and Hydraulic Production Tool Equipment

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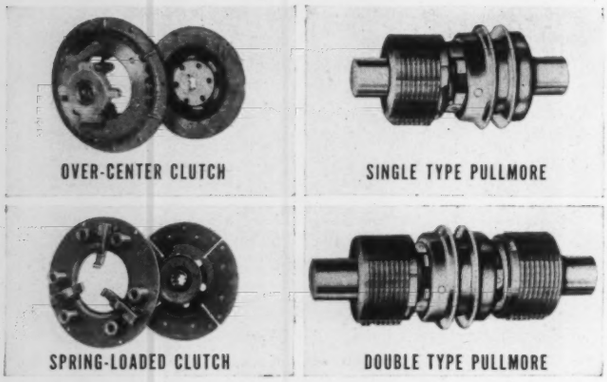
HANNIFIN
IMPROVED AIR CYLINDERS

Rockford Clutches for Industrial Equipment



Rockford Clutches

Spring-Loaded and Over-Center, are ideal for use in gasoline and diesel-engine driven equipment. The O-C Clutch remains in or out of engagement until changed by the operator, exclusive anti-friction roller cams make operation extremely easy; the Spring-Loaded type operates like an automobile clutch. Corresponding sizes are generally interchangeable. Rockford Clutches are available with single or double drive plates, for operation in oil or dry in capacities up to 80 h.p. at 100 r.p.m.

Pullmore Clutches

Are unexcelled for applications requiring a multiple disc clutch. They are used effectively as main drive clutches carrying all the load; as auxiliary clutches controlling individual units; and in power take-off mechanisms to operate various attachments. Pullmore Clutches are available in single and double types, for operation in oil or dry, in capacities from 1 h.p. to 75 h.p. at 500 r.p.m.

ROCKFORD DRILLING MACHINE DIVISION
Borg-Warner Corporation, 304 Catherine Street, Rockford, Illinois

for Flexibility and Economy

. . . use Rotary Geared MOTORPUMPS

— flexible in installation
— save expensive power take-off

3 sizes—Nos. 101-102-103
Brown & Sharpe Mfg. Co.,
Providence, R. I., U. S. A.

BROWN & SHARPE PUMPS

B·S

Co. also recently announced the appointment of Paul R. Urich, 1045 West Twenty-sixth street, Erie, Pa., as representative in the Erie territory.

♦

Charles Bond Co., Philadelphia, has appointed F. Raniville Co., 241-247 Pearl street, Northwest, Grand Rapids, Mich., as distributor for its line of stock gears and speed reducers.

♦

Organization of Continental Aeronautic Corp. has recently been made in Burbank, Calif. The company, headed by E. J. Rivers, former executive of North American Aviation Inc., has acquired a factory and will begin to manufacture metal aircraft parts.

♦

Cleveland representatives of The Oilgear Co., Milwaukee, Messrs. E. C. Wollaeger and I. X. Calhoun, have moved their offices to 3109 Mayfield road.

♦

With headquarters at West Hartford, Conn., Ralph Hare has been made New England representative of Electro-Alloys Co., Elyria, O.

♦

For the past 12 years identified with the metallurgical and sales departments of Wheelock, Lovejoy & Co. Inc., Cambridge, Mass., Arden L. Knight has been appointed district manager of sales in New England. His offices will be at 128 Sidney street, Cambridge, Mass.

♦

Resigning as manager of sales, sheet division of Carnegie-Illinois Steel Corp., Pittsburgh, Avery C. Adams has accepted a position as vice president and assistant general manager of sales of Inland Steel Co., Chicago.

♦

R. J. Schuler, who became associated with Republic Steel Corp. last spring after serving 13 years in various sales capacities with LaSalle Steel Co., has been appointed assistant manager of sales, bolt and nut division, with headquarters in Cleveland. His previous position was that of general sales representative, Union Drawn Steel division of Republic.

♦

Reconstruction and modernization of its pipe and tube mill at Bridgeport, Conn., has recently been started by Bridgeport Brass Co. Modernization of the pipe and tube mill will provide additional facilities for making new alloy tubing, and at the same time make available space for larger quantities of finished stocks.

♦

Following additional companies have been licensed by Meehanite Metal Corp., Pittsburgh, to manufacture Meehanite Metal under the Meehanite processes: Valley Iron Works, St. Paul, Minn., Barnett Foundry & Machine Co., Newark, N. J., Herbert Morris Ltd., Loughboro, England and Douglas Fraser & Sons Ltd., Arbroath, Scotland.

♦

General Electric Co. has appointed Robert A. Jones, formerly engineer at the company's Buffalo office, as assistant engineer for the company in the New York

Provide a "Selective" Control

The simple start and stop of any power movement, the most complex interlocking sequence of operation, and all the varying operation requirements that go between are handled equally well by

T-J REMOTE CONTROLS (Pneumatic)

"Right" from all angles---

- May be arranged to provide complete safety for the operator, for the work, and for the machine.
- Ably handles production requirements—provides fast operation without fatigue.
- Requires practically no maintenance attention.

These in addition to its competently handling simple or complex operating cycles. Bulletin No. 3 will give you more facts. Write for it now, include a description of your problem so that we may assist you in the selection of the proper units.

THE TOMKINS-JOHNSON CO.
618 N. Mechanic Street, Jackson, Michigan

Let IXL SPEED REDUCERS help you sell your product!

YOUR customers and prospects recognize the IXL trademark as the symbol of the best in gearing, built by an organization with over 77 years experience. This wide acceptance is a sound basis for your use of IXL speed reducers as a part of the equipment you build. This trademark can aid in establishing the quality of your equipment, can help you sell it.

More than that, this acceptance indicates recognition of leadership, indicates the reliability you can obtain from IXL gearing for your own power transmission.

IXL
The Mark of Quality

FREE IXL HANDBOOK

Executives, designers and engineers can secure this 640 page reference volume of tables, charts and data free upon request.

•

IXL PRODUCTS

Complete line of Speed Reducers
Powered Gears
Special Drives
Gears of All Kinds.

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Designing Mechanical Springs for Machine Use

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Limited number of reprints of this four-part series still available. Price fifty cents per copy.

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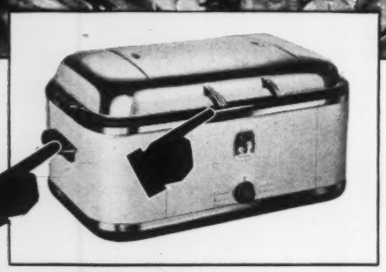
Write now for this comprehensive listing of materials, including alloys, plastics and other nonmetallics; also producers of stampings, forgings, die castings, and plastic molders. Twenty-five cents per copy. Special schedule of rates for copies in quantities.

MACHINE DESIGN

Penton Building Cleveland, Ohio

The *Beautiful*..New
NESCO
Electric Roaster..

with
COOL
HANDLES



Eclipse MOULDED..

Nesco designers and engineers handed down a set of rigid specifications for their Electric Roaster handles. They had to be streamlined, withstand 450°, and stay cool.

And Eclipse designers, thoroughly experienced in all types of plastics, were able to give them exactly what they wanted.

Nesco electric Roaster is another example of Eclipse's thorough and varied service in Moulded Products for all industries. From our wide experience with Plastics of all types, we are glad to show you a new way to **greater product-beauty, improved utility, and savings in production and assembly costs.**

●

ECLIPSE MOULDED PRODUCTS CO.
Milwaukee, Wisconsin
Chicago Detroit St. Louis

●

MOULDERS of . . .
Bakelite, Durez, Resinox, Plaskon, Tenite, Beetle, Etc.

●

Important Reason . . .
for calling on Eclipse for Modern Moulded Plastics!

Eclipse Designers, Engineers, Craftsmen are trained in moulding ALL PLASTICS. They know which of the many available modern plastic materials will most profitably serve your needs. Call upon Eclipse for an UNBIASED recommendation.

district. W. C. Plumer of the company's Newark office has been transferred to Buffalo as engineer, and L. F. Stone has been made engineer at Newark, replacing Mr. Plumer.

♦

Succeeding George A. Burnham, recently resigned, W. S. Edsall, formerly sales manager, has been made assistant manager of the electrical department in charge of switchgear sales and engineering division of the Conduit Works of Allis-Chalmers Mfg. Co., Boston, Mass.

♦

According to a recent announcement by Amercoat Sales Agency, Huntington Park, Calif., exclusive distributors of Amercoat cold-applied, synthetic organic plastic, corrosion-resistant coatings, manufactured by American Concrete & Steel Pipe Co., South Gate, Calif., Robert E. Lanier & Co., Electric building, Houston, Texas, has been appointed exclusive distributor of Amercoat products for the states of Texas, Oklahoma, Arkansas, Louisiana and Mississippi. Activities will be under the direction of Everard W. Baker.

♦

Succeeding the late K. W. Nelson, W. H. Milton Jr. has assumed duties of manager of sales for the plastics department of General Electric Co., Pittsfield, Mass. Mr. Milton has been with the company since immediately after his graduation from Virginia Military institute in 1920.

♦

Steel Founders' Society of America, representing over 95 per cent of the steel foundries in the United States, has inaugurated a campaign to bring to chief engineers and designers the advantages of using steel castings in the design of machines. For years steel castings have been found indispensable by the railroad and automobile industries, and their use in industrial machinery is steadily increasing.

›

For the past two years director of the business development program of the electric welding section of the National Electrical Manufacturers' association, Harold S. Card has inaugurated a sales, advertising and general promotional consulting service for manufacturers of welding equipment and materials. His headquarters are in room 517, 30 Church street, New York.

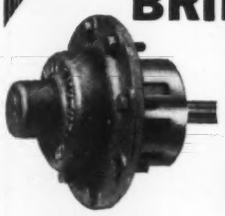
♦

Lead-bearing steels, developed by Inland Steel Co. during the past year, are becoming increasingly popular with manufacturers. Bethlehem Steel Co. has just taken out a license to make these steels under the Inland patents.

♦

F. S. Chase, president of Chase Brass & Copper Co. Inc., has been elected president of Copper and Brass Research association. John A. Coe, president of American Brass Co., C. D. Dallas, president of Revere Copper & Brass Inc., and Wylie Brown, president of Phelps Dodge Copper Products Corp., were elected vice presidents.

WHERE QUIET BRINGS RESULTS



Yes . . . you need quiet pump performance for results, too. That's why our engineers have designed Tuthill "Stripped Pumps" for quiet operation. Remember—you can save space, reduce cost and improve appearance by building the pumping elements directly into the design of your machine with Tuthill "Stripped Pumps." Capacities up to 50 g. p. m.

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at your service . . .

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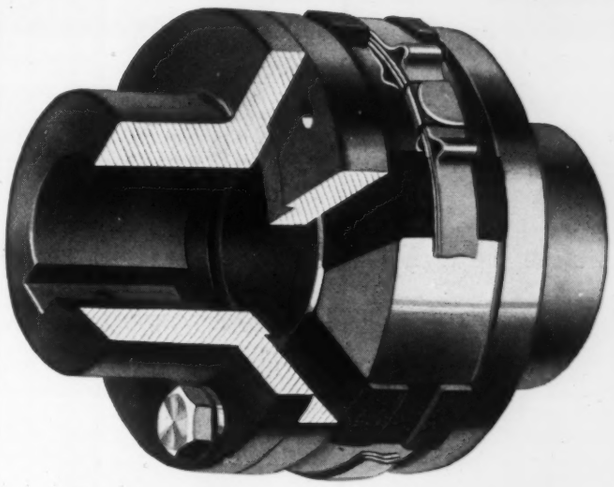

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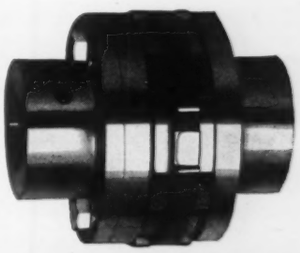
Design permits rotation of either shaft, timing of engine or removal of either element without moving machine or tear-down of coupling.



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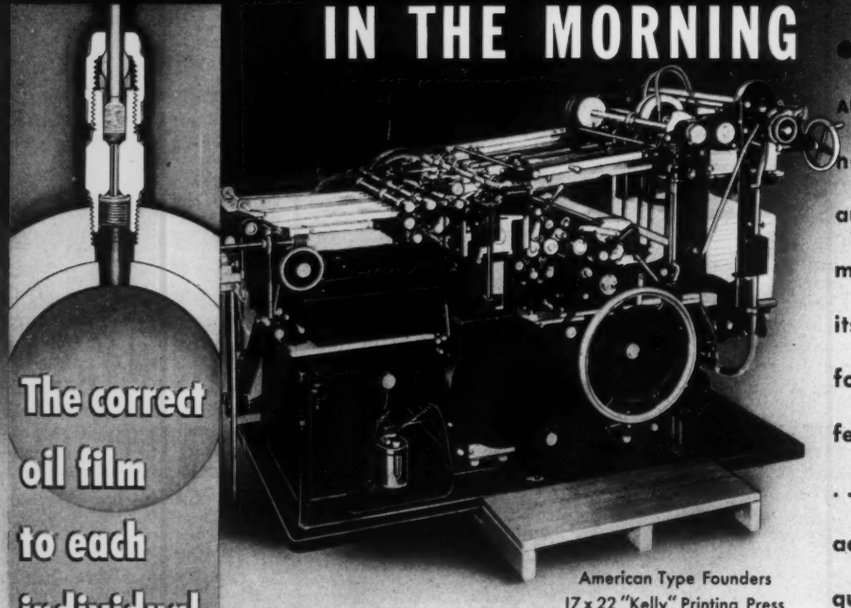

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Fig. 1446

Knurled "UNBRAKO" Socket Head Stripper Bolt. Knurled head turns easier; socket head permits compact designs.

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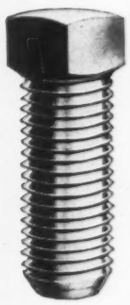

Fig. 1507

"UNBRAKO" Square Head Set Screw. Made from extraordinarily strong alloy steel. Can be supplied with any style point.

Fig. 232

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Fig. 1434

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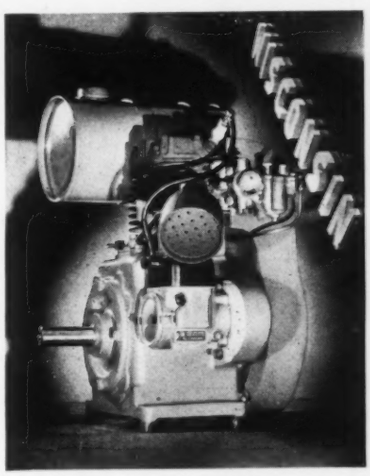

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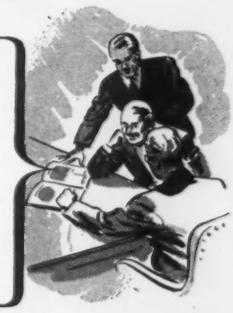
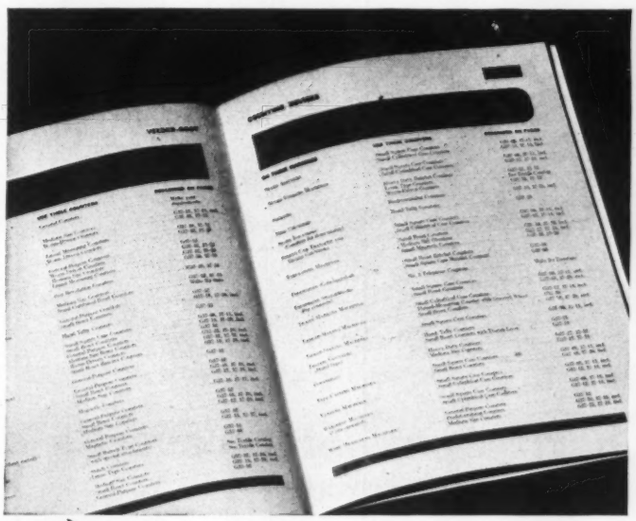
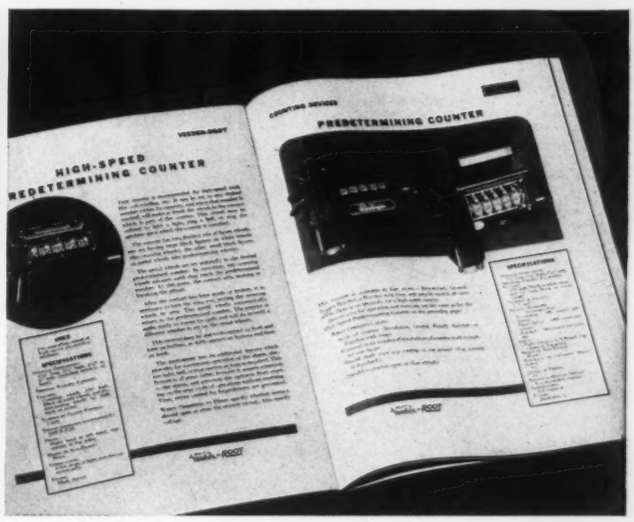
of how hundreds of manufacturers find Profitable ways to use Veeder-Root counting devices



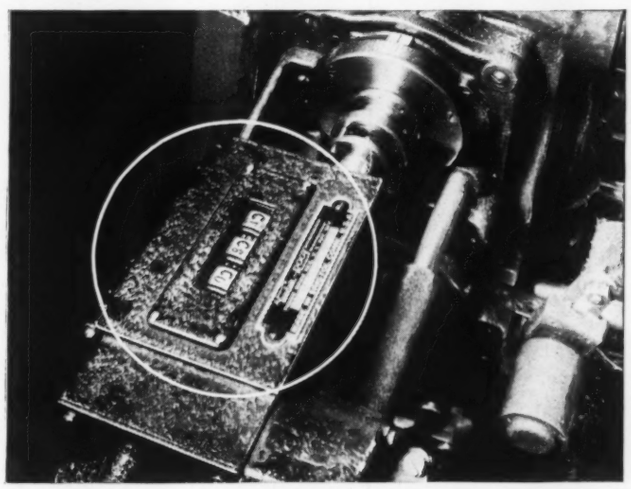
TAKEN FROM VEEDER-ROOT'S BIG COMPLETE CATALOG OF COUNTERS FOR EVERY PURPOSE



1. QUICK FINDING INDEX. Step number one for the manufacturer is to look at our catalog's quick-finding index listing alphabetically, hundreds of machines and the counters commonly used. The manufacturer finds his machine—or one very similar—and sees at a glance the counters that can be profitably applied to his machine.



2. FULL DESCRIPTION OF COUNTER. From the quick-finding index the manufacturer turns to the page featuring the counter that can be used on his machine. He sees what the counter can do for him. He gets all the information he wants—descriptions, specifications, and complete operating and installing instructions.



3. INSTALLATION PHOTO. Then, in the back of our catalog, the manufacturer sees, among many other installation photographs, the type of counter he wants to use completely installed in a machine similar to his. He can tell how easy and economical the counter is applied—how visible and practical it can be.

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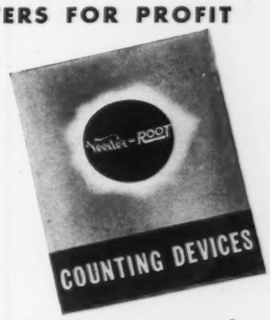

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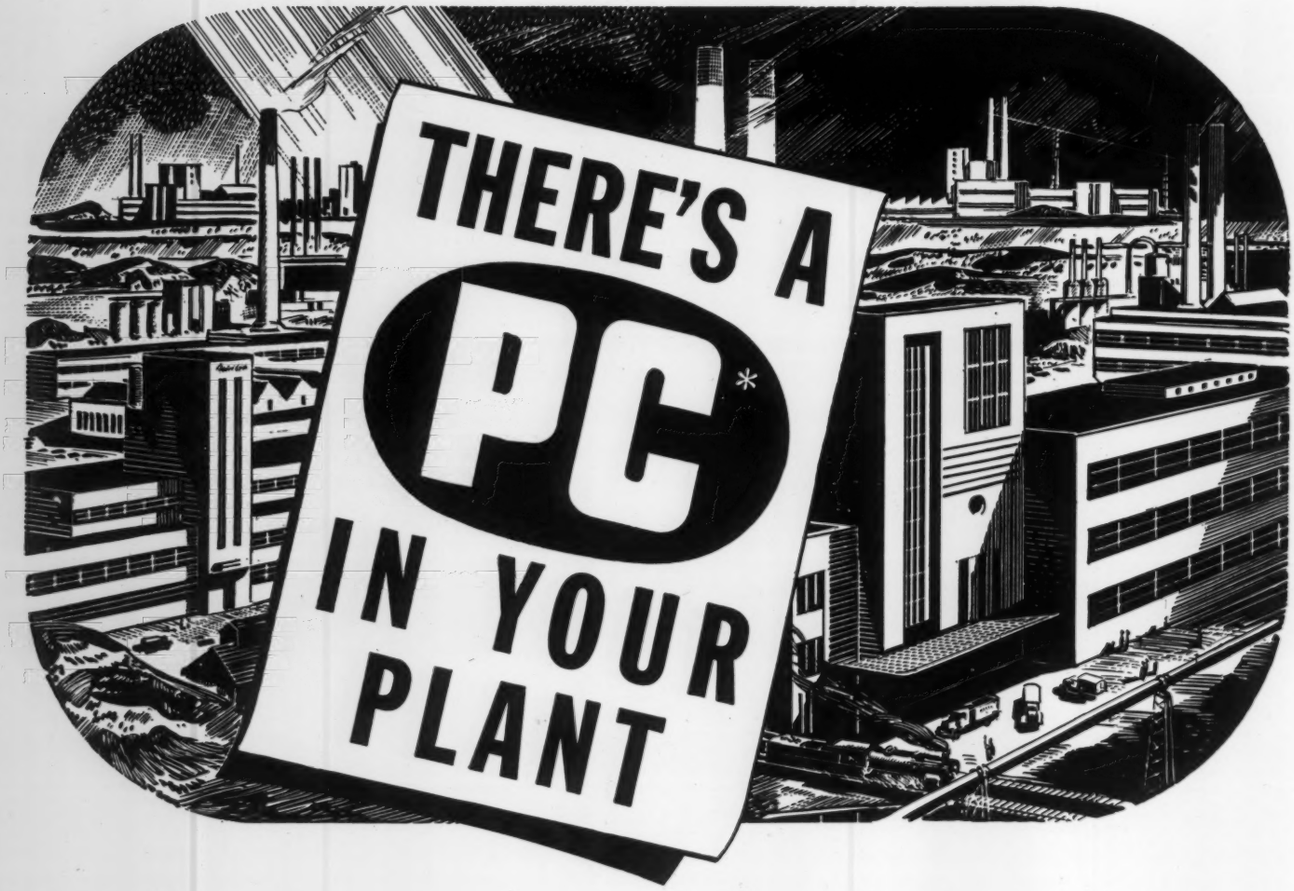

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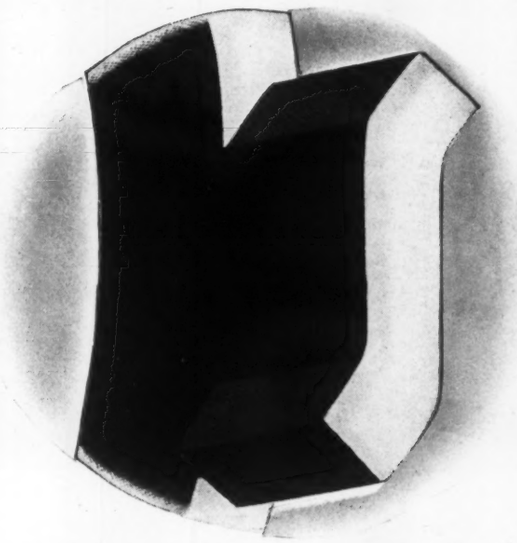

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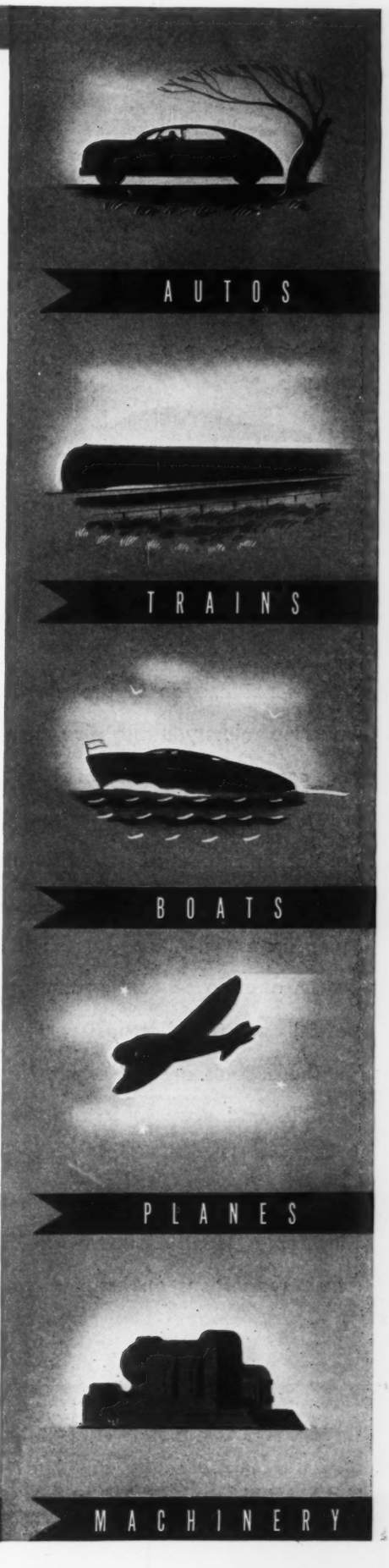
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